NAME:

If you do not wish to have your script placed outside my office, then please check this box.____

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)

\[
\begin{align*}
\text{O} & \quad \text{CH}_2 & \quad \text{N-R} & \quad \text{O} \\
\text{R-C-R} & \quad \text{R-C-R} & \quad \text{R-C-H} & \quad \text{R-C-Cl}
\end{align*}
\]

2) Draw a Lewis structure including lone pairs for a molecule of the following general classes: (10.5pts)

*Alkyl Diazonium Salt*

*Ketone hydrate*

*Isocyanate*
3) Circle the stronger base in the following pairs, and in a sentence explain your choice. (10pts)

(a) \( \text{CH}_3\text{-NH}_2 \) \( \text{NH}_3 \)

(b) \[
\begin{array}{c}
\text{HN-CH}_3 \\
\text{O}
\end{array}
\] \[
\begin{array}{c}
\text{HN-CH}_3 \\
\text{O}
\end{array}
\]

(c) \( \text{NH}_3 \) \( ^+\text{NH}_4 \)

(d) \[
\begin{array}{c}
\text{N}
\end{array}
\] \[
\begin{array}{c}
\text{H}_3\text{C-CH}_3 \\
\text{NH}
\end{array}
\]

(e) \( \text{NH}_3 \) \( \text{H}_2\text{O} \)
4) Name the following compounds in IUPAC acceptable terms. (12pts)

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

H—CH₂F

H—CH₃

Ph—CH₂Ph

Ph—CH₂Ph
6) The reaction of 2-butanone with NaBH₄ (sodium borohydride) followed by addition of acid yields a chiral product.

(i) Draw the product(s) (2pts)

(ii) what class of organic compound is the product? (2pts)

(iii) what is the name of the general class of this reaction? (2pts)

(iv) is the product mixture optically active or racemic? Explain your choice. (4pts)

(v) Draw the mechanism for this reaction (8pts)
7) Give the products formed in five of the following reactions. (15pts)

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

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

(c) \[\text{NH}_2\] 
excess Ph-C-Cl

(d) \[\text{H}_3\text{C} - \text{C} - \text{H}\] 
1) Ph\(_3\)P, CH\(_3\)CH\(_2\)-Br 
2) BuLi 
3) warm

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

(f) \[\text{O-Tos}\] 
KCN \[\rightarrow \text{A}\] 
LiAlH\(_4\), H\(_2\)O
8) Give reagents for the following transformations. (9pts)

9) Write the mechanism for the acid catalyzed hydration of propanone (acetone) (8.5pts)

*Bonus question* (up to 3pts)
Write the mechanism for the reaction of aniline with nitrous acid to generate a diazonium salt.
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)

\[ \text{O} \quad \text{CH}_2 \quad \text{N-R} \quad \text{O} \quad \text{R-C-R} \quad \text{R-C-R} \quad \text{R-C-H} \quad \text{R-C-Cl} \]

KETONE  ALKENE  IMINE  ACID

CHLORIDE

2) Draw a Lewis structure including lone pairs for a molecule of the following general classes: (10.5pts)

**Alkyl Diazonium Salt**

\[ R-N^+_\text{EN} \]

**Ketone hydrate**

\[ R-C-H \quad \text{H-O} \quad \text{H-O} \quad \text{H} \]

**Isocyanate**

\[ R-N=C=O \]
3) Circle the stronger base in the following pairs, and in a sentence explain your choice. (10pts)

(a) \( \text{CH}_3\text{-NH}_2 \) \( \text{NH}_3 \)
- Alkyl group helps stabilize the ammonium salt formed after protonation.
- The RH₂ amide has the N-LF stabilized through conjugation with the aromatic π system.

(b) \( \text{HN-CONH}_2 \) \( \text{HN-CONH}_2 \)

(c) \( \text{NH}_3 \) \( ^+\text{NH}_4 \)
- \(^+\text{NH}_4 \) has no lone pairs and cannot function as a base.

(d) \( \text{H}_3\text{C-\text{NH}} \) \( \text{H}_3\text{C-\text{NH}} \)
- \( \text{SP}^3 \) orbital holds the LP vs. \( \text{SP}^2 \); is less tightly held & more easily protonated.

(e) \( \text{NH}_3 \) \( \text{H}_2\text{O} \)
- \( \text{N} \) is less electronegative than \( \text{O} \); LP less tightly held.
- Also \( \text{H}_4\text{N}^+ \) more dissociate than \( \text{H}_3\text{O}^+ \) due to electronegativity.
4) Name the following compounds in IUPAC acceptable terms. (12pts)

2-methylcyclobutanone

2-Fluorohept-3-one

But-3-en-2-amine

(E)-4-Bromobut-3-enal

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

The LHS carbonyl carbon is more +ve due to the electron withdrawing F group. Therefore nucleophiles are more strongly attracted to it.

The LHS carbonyl carbon is much less sterically hindered and is easier to approach by an incoming nucleophile.
6) The reaction of 2-butanone with NaBH₄ (sodium borohydride) followed by addition of acid yields a chiral product.

(i) Draw the product(s) (2pts)

(ii) What class of organic compound is the product? (2pts) *ALCOHOL*

(iii) What is the name of the general class of this reaction? (2pts) *REDUCTION / NUC ADDITION / HYDRATION*

(iv) Is the product mixture *optically active* or *racemic*? Explain your choice. (4pts) *Racemic. Equal amounts of each enantiomer will be formed.*

(v) Draw the mechanism for this reaction (8pts)
7) Give the products formed in five of the following reactions. (15pts)

(a) \[ \text{H}_3\text{C} - \text{C} - \text{CH}_3 \] 
\[ \rightarrow \text{PhCH}_2\text{MgBr} \] 
\[ \rightarrow \text{H}_3\text{O}^+ \]

(b) \[ \text{NH}_2 \] 
\[ \rightarrow \text{excess CH}_3\text{CH}_2\text{CH}_2\text{-Br} \]

(c) \[ \text{NH}_2 \] 
\[ \rightarrow \text{excess Ph-\text{C}-\text{Cl}} \]

(d) \[ \text{H}_3\text{C} - \text{C} - \text{H} \] 
\[ \rightarrow 1) \text{Ph}_3\text{P, CH}_3\text{CH}_2\text{-Br} \] 
\[ 2) \text{BuLi} \] 
\[ 3) \text{warm} \]

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

(f) \[ \text{Ph-OTos} \] 
\[ \rightarrow \text{KCN} \] 
\[ \rightarrow \text{LiAlH}_4, \text{H}_2\text{O} \]
8) Give reagents for the following transformations. (9pts)

\[
\text{\begin{center}
\begin{array}{c}
\text{[Image of chemical reactions]}
\end{array}
\end{center}}\]

9) Write the mechanism for the **acid** catalyzed hydration of propanone (acetone) (8.5pts)

\[
\text{\begin{center}
\begin{array}{c}
\text{[Image of mechanism diagram]}
\end{array}
\end{center}}\]

*Bonus question* (up to 3pts)
Write the mechanism for the reaction of aniline with nitrous acid to generate a diazonium salt.

\[
\text{\begin{center}
\begin{array}{c}
\text{[Image of diazonium salt mechanism]}
\end{array}
\end{center}}\]

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