Summer 2017 Organic I Final Exam 100pts (graded as 150pts)

Name

(1 a-j) are TRUE/FALSE (10pts)

a) A nucleophile is a two electron donor.

b) One definition of an acid is a proton donor.

c) 2,2-Dibromobutane is a geminal dihalide.

d) All alkenes have a carbon-carbon triple bond.

e) $S_N1$ and $S_N2$ reactions are types of addition reaction.

f) The rate determining step is always the quickest step.

g) An anion has a positive charge.

h) A typical C-C bond length is around $1.1 \times 10^{-10}$ m.

i) Pent-2-ene and Cyclopentene are isomers.

j) Cyclopropanol has six Hydrogens.

2) Define the following terms (4pts):

*Elimination reaction*

*Chirality*

*Syn Addition*

*Structural isomer*
3) Name the classes of compound that the following molecules belong to (E.g. alkane, amide, etc). (6pts)

\[
\begin{align*}
&\text{R-SH} & \text{R-OOR} & \text{R-OR} \\
&\text{O} & \text{O} & \text{O} \\
&\text{R-O-H} & \text{R-H} & \text{R-O-R} \\
\end{align*}
\]

4) (3pts) For PROPYNE:

How many Carbons are there?

How many Hydrogens?

What are the (two different) hybridizations of the Carbon atoms?

5) Write a mechanism (i.e. curly arrows) for this electrophilic addition. (5pts)

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH}_3 & \quad \text{H-Br} & \quad \text{H}_3\text{C} \quad \text{CH}_3 \\
\text{H} & \quad \text{CH}_3 & & \text{H} \quad \text{Br} \\
\end{align*}
\]

What is the regiochemistry of this reaction? (1pt)
6) Name the following molecules in IUPAC form. (12pts)

(a) 

(b) 

(c) 

7) Assign R or S to each chiral center in these molecules. (6pts)

(a) 

(b) 

(c)
8) (i) Write a mechanism (i.e. curly arrows) for this E1 elimination. (5pts)

9) Give the reagents for the following alkene reactions. (8pts)
10) Circle the most stable member in each part. (2x6=12pts)

(a) 

(b) 

NH₂

(c) 

\[
\begin{align*}
&\text{[ } - & \text{]} \\
\text{[ \text{[ } - & \text{]} - ]}
\end{align*}
\]

(d) 

\[
\begin{align*}
&\text{[ } - & \text{]} \\
\text{[ \text{[ } - & \text{]} - ]}
\end{align*}
\]

(e) 

F⁻, Cl⁻, I⁻

(f) 

\[
\begin{align*}
&\text{[ } - & \text{]} \\
\text{[ \text{[ } - & \text{]} - ]}
\end{align*}
\]
11) Give the reagents (for b, d & e), and the products (for a & c). (10pts)

a) \[ \text{H}_3\text{C} \equiv \text{C} \equiv \text{C} \equiv \text{H} \] \[ \xrightarrow{\text{HBr, Peroxides}} \]

b) \[ \text{OH} \]

c) \[ \text{H}_3\text{C} \equiv \text{C} \equiv \text{C} \equiv \text{H} \]
   \[ \xrightarrow{\text{i) } \text{R}_2\text{BH}} \]
   \[ \xrightarrow{\text{ii) } \text{H}_2\text{O}_2, \text{NaOH}} \]

d) \[ \text{cis-pent-2-ene} \]

e) \[ \text{Cl} \]

12) Draw in the arrows for the following anti addition mechanism. (5pts)

\[ \text{} \]

\[ \text{Br} \]

\[ \text{Br} \]

\[ \text{Br} \]

\[ \text{Br} \]

\[ \text{Br} \]

\[ \text{Br} \]
13) Give the products for the following transformations. (8pts)

\[
\text{Chromic Acid (H}_2\text{CrO}_4) \quad \text{PCC} \quad \text{PCl}_3 \quad 1) \text{Pyridine, Tos-Cl} \quad 2) \text{LiAlH}_4
\]

14) Draw in the arrows for the following mechanism. (5pts)

\[
\text{O}^+ \quad \text{Na}^+ \quad \text{NH}_3 \quad \cdot\cdot\cdot \text{Cl}^- \quad \text{O}^+ \quad \text{Cl}^-
\]

\[
\text{O}^+ \quad \text{Na}^+ \quad \text{NH}_3 \quad \cdot\cdot\cdot \text{Cl}^- \quad \text{O}^+ \quad \text{Cl}^-
\]
**BONUS POINTS (up to TWO)**

Provide an everyday (macroscopic scale) example of:

- an increase in Entropy.

- a chiral object.
(1 a-j) are TRUE/FALSE (10pts)

a) A nucleophile is a two electron donor. \( \text{True} \)

b) One definition of an acid is a proton donor. \( \text{True} \)

c) 2,2-Dibromobutane is a geminal dihalide. \( \text{True} \)

d) All alkenes have a carbon-carbon triple bond. \( F \)

e) \( S_N1 \) and \( S_N2 \) reactions are types of addition reaction. \( F \)

f) The rate determining step is always the quickest step. \( F \)

g) An anion has a positive charge. \( F \)

h) A typical C-C bond length is around \( 1.1 \times 10^{-10} \) m. \( F \)

i) Pent-2-ene and Cyclopentene are isomers. \( F \)

j) Cyclopropanol has six Hydrogens. \( \text{True} \)

2) Define the following terms (4pts):

\textit{Elimination reaction}

\textit{The removal of two atoms or groups to produce a \( \Pi \) bond.}

\textit{Chirality}

\textit{When an object has a \textit{non-superimposable mirror image.}}

\textit{Syn Addition}

\textit{Addition of two atoms or groups to the same face (of a \( \Pi \) bond)}

\textit{Structural isomer}

\textit{Same molecular formula but different bond connectivity.}
3) Name the classes of compound that the following molecules belong to (E.g. alkane, amide, etc). (6pts)

\[
\begin{align*}
R-SH & \quad \text{Thiol} \\
R-OOR & \quad \text{Peroxide} \\
R-OR & \quad \text{Ester}
\end{align*}
\]

\[
\begin{align*}
R-O-H & \quad \text{Carboxylic Acid} \\
R-C-H & \quad \text{Aldhyde} \\
R-CO-R & \quad \text{Ester}
\end{align*}
\]

4) (3pts) For PROPYNE:

- How many carbons are there? \(3\)
- How many hydrogens? \(4\)
- What are the (two different) hybridizations of the Carbon atoms? \(s^\text{p}^2 & s^\text{p}\)

5) Write a mechanism (i.e. curly arrows) for this electrophilic addition. (5pts)

What is the regiochemistry of this reaction? (1pt) Markovnikov
6) Name the following molecules in IUPAC form. (12pts)

(a) 
\[ \text{3-cyclopentyl octane} \]

(b) 
\[ \text{(E)-1-Bromo-1-fluorobut-1-ene} \]

(c) 
\[ \text{cis-3-Methylcyclohexanol} \]

7) Assign R or S to each chiral center in these molecules. (6pts)

(a) 
\[ \text{S} \]

(b) 
\[ \text{R} \]

(c) 
\[ \text{S} \]
8) (i) Write a mechanism (i.e. curly arrows) for this E1 elimination. (5pts)

9) Give the reagents for the following alkene reactions. (8pts)
10) Circle the most stable member in each part. (2x6=12pts)

(a)  
\[ \text{H}_3\text{C} \quad \text{H}_3\text{C} \quad \text{H}_3\text{C} \]

(b)  
\[ \text{CH}_3\text{CH}_2\text{NH}_2 \quad \text{CH}_3\text{CH}_2\text{NH}_2 \quad \text{CH}_3\text{CH}_2\text{NH}_2 \]

(c)  
\[ \begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \\
\longrightarrow
\end{array} \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \]

(d)  
\[ \begin{array}{c}
\text{CH}_3\text{CH}_2\text{NH}_2 \\
\longrightarrow
\end{array} \quad \text{CH}_3\text{CH}_2\text{NH}_2 \]

(e)  
\[ \text{F}^- \quad \text{Cl}^- \quad \text{I}^- \]

(f)  
\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \]
11) Give the reagents (for b, d & e), and the products (for a & c). (10pts)

a) \[ \text{H}_3\text{C} = \text{C} \equiv \text{C} - \text{H} \quad \text{HBr, Peroxides} \quad \text{Br} \quad \text{Br} \]

b) \[ \text{H}_2\text{O} \quad \text{CH}_3\text{CH}_2\text{H}_2\text{Br} \quad \text{OH} \]

c) \[ \text{H}_3\text{C} = \text{C} \equiv \text{C} - \text{H} \quad \text{i) } \text{R}_2\text{BH} \quad \text{ii) } \text{H}_2\text{O}_2, \text{ NaOH} \quad \text{[ } \text{CH}_2 = \text{CH}_2 \text{]} \rightarrow \text{CH}_2 = \text{C} = \text{O} \]

d) \[ \text{H}_3\text{C} = \text{C} = \text{CH}_2\text{CH}_3 \quad \text{H}_2, \text{ Lindlar’s Catalyst} \quad \text{cis-pent-2-ene} \]

e) \[ \text{H}_3\text{C} = \text{C} = \text{CH}_3 \quad \text{2 equiv. } \text{Cl}_2 \quad \text{Cl} \quad \text{Cl} \quad \text{Cl} \quad \text{Cl} \]

12) Draw in the arrows for the following *anti* addition mechanism. (5pts)

\[ \text{Br} \quad \text{Br} \quad \text{Br} \quad \text{Br} \quad \text{Br} \]
13) Give the products for the following transformations. (8pts)

\[
\text{Cyclopentane COOH} \xrightarrow{\text{Chromic Acid (H}_2\text{CrO}_4\text{)}} \text{Cyclopentene} \xrightarrow{\text{PCC}} \text{Cyclohexanol} \xrightarrow{\text{PCl}_3} \text{Cyclohexane} \\
\]
1) Pyridine, Tos-Cl
2) LiAlH\textsubscript{4}

14) Draw in the arrows for the following mechanism. (5pts)

\[
\text{Cyclohexanol} \xrightarrow{\text{Na}^+ \cdot \text{NH}_3} \text{Cyclohexyl}^+ \cdot \text{Cl}^- \xrightarrow{\text{Na}^+} \text{Cyclohexyl chloride}
\]
***BONUS POINTS (up to TWO).***

Provide an everyday (macroscopic scale) example of:

- an increase in Entropy.
  - Wake up and your hair is a mess.
  - Your garden gets messy if you do not weed it.
  - You have to make your bed in the morning.
  ... elz

- a chiral object.
  - hand
  - glove
  - shoe
  - golf club
  - scissors
  - car
  - corkscrew
  - dice
  ... elz