Fall 11 Organic I Final Exam 200pts (graded as 300pts)

Name
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Answer all the questions

(1-10) Are True or False (20pts)

1) Organic Chemistry is the study of Carbon containing compounds

2) A π covalent bond must be polar

3) The Cahn-Ingold and Prelog convention describes rules for assigning (+) and (-) to chiral centers

4) The Hammond Postulate states that entropy is inverted at a neutral chiral cation

5) A typical C=C bond length is around 1.3 x 10^{-5} m

6) For X chiral centers, there are X^2 maximum possible stereoisomers

7) The change in Gibbs free energy can be expressed as ∆G = ∆H — T∆S

8) HO^- is a stronger base than H_2O

9) Increasing the reaction temperature encourages elimination reactions relative to substitution reactions

10) Organometallic reagents have a metal connected to a carbon

Define the following terms (8pts)

11) Nucleophile

12) Lewis Acid

13) Meso compound

14) Kinetics
15) Name the classes of compound that the following molecules belong to (E.g. alkane, amide, etc). (20pts)

![Molecule Diagrams]

16) (18pts) For the following molecule, calculate the number of …

![Molecule Diagram]

a) carbon atoms
b) hydrogen atoms
c) π bonds
d) sp² hybridized carbons
e) sp hybridized atoms
f) halogens
g) lone pairs (non bonding pairs) of electrons
h) the C-O-C bond angle
i) carbons in the ring
17) For each of the following reactions state whether the regiochemistry is Markovnikov, Anti-Markovnikov or Neither. (12pts)

18) In the lowest energy conformation of trans-1,2-dimethylcyclohexane, how many axial positions are occupied by Hydrogen atoms? (6pts)
19) (i) Write a mechanism (i.e. curly arrows) for this E1 elimination. (8pts)

\[ \text{Br} \quad \xrightarrow{\text{K}^+ \text{OCH}_3, \text{CH}_3\text{OH}} \quad \cdot \text{Br} \]

ii) Is the above product Hoffman or Saytzeff? (3pts)

iii) There is also another (minor) alkene product that is formed from this elimination, draw this product. (3pts)

20) Draw the following molecules: (10pts)

3-Fluoro-1-pentyne  \hspace{1cm} \text{cis-2-Methylcyclobutanol}
21) Explain (including curly arrows) why in this electrophilic addition reaction, none of product A is generated, and product B is formed exclusively. (10pts)

![Diagram of electrophilic addition reaction]

22) Name the following compounds in IUPAC format. (8pts)

(a) \( \text{OH} \)

(b) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{H} \)

\( \text{CH}_2\text{H}_2\text{CH}_2\text{Br} \)
23) Assign R or S to each chiral center in these molecules. (12pts)

(a) 
\[
\begin{array}{c}
\text{H}_3\text{C} \text{C}^2\text{F} \text{H}_2 \\
\text{H}_2 \text{C}^\text{N} \text{H}_2
\end{array}
\]

(b) 
\[
\begin{array}{c}
\text{H}_3\text{C} \text{H} \text{H} \text{O} \\
\text{H}_2 \text{C} \text{O} \text{H}
\end{array}
\]

(c) 
\[
\begin{array}{c}
\text{H}_3\text{C} \text{H} \text{H} \text{Cl} \\
\text{H} \text{H} \text{Cl}
\end{array}
\]

(d) 
\[
\begin{array}{c}
\text{H}_3\text{C} \text{H} \text{H} \text{Cl} \\
\text{Cl} \text{H} \text{CF}_2\text{H}
\end{array}
\]

24) What is the name of this type of Projection? (2pts)

(b) What is meant by the term \textit{diastereomer}? (2pts)

c) Draw two molecules that are \textit{structural isomers} (5pts)
25) Circle the most stable member of each threesome. (12pts)

(a) 

(b) 

(c) 

(d) 

(e) 

(f)
26) Give the reagents or products for 6 of the 8 following reactions. (18pts)

(a) \[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH} &= \text{CH}_2 \\
\text{CH}_3\text{CH}_2\text{CH} &= \text{CH}_2 \\
\text{CH}_3\text{CH}_2\text{CH} &= \text{CH}_2
\end{align*}
\]

(b) \[
\begin{align*}
\text{H}_3\text{C} &= \text{C}=\text{C} \rightarrow \text{H} \\
\text{NaNH}_2
\end{align*}
\]

(c) \[
\begin{align*}
\text{C} &= \text{C} \rightarrow \text{C} \\
\text{OH}
\end{align*}
\]

(d) \[
\begin{align*}
\text{C} &= \text{C} \rightarrow \text{C} \\
\text{H}_3\text{C} &= \text{C} \rightarrow \text{H}_3\text{C} \text{ and } \text{H}_3\text{C} \text{ and } \text{H}_3\text{C}
\end{align*}
\]

(e) \[
\begin{align*}
\text{H}_3\text{C} &= \text{C}=\text{C} \rightarrow \text{H} \\
\text{Excess HCl}
\end{align*}
\]

(f) \[
\begin{align*}
\text{H}_3\text{C} &= \text{C}=\text{C} \rightarrow \text{H} \\
\text{HgSO}_4, \text{H}_2\text{SO}_4, \text{H}_2\text{O}
\end{align*}
\]

(g) \[
\begin{align*}
\text{H}_3\text{C} &= \text{C}=\text{C} \rightarrow \text{H}_2 \\
\text{H}_2 \text{ Lindlar's Catalyst}
\end{align*}
\]

(h) \[
\begin{align*}
\text{C} &= \text{C} \rightarrow \text{C} \\
\text{O}
\end{align*}
\]
27) Give the products in 5 of the 6 following transformations. (15pts)

28) Draw curly arrows to show the mechanism of the following $S_N 1$ reaction. (8pts)
**Bonus question (up to 6 points).**

What were the three joke names used for the perfect answers to this year’s three exams?
Fall 11 Organic I Final Exam

Name: Yule B. Appy

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Answer all the questions

(1-10) Are True or False (20pts)

1) Organic Chemistry is the study of Carbon containing compounds True

2) A π covalent bond must be polar False

3) The Cahn-Ingold and Prelog convention describes rules for assigning (+) and (−) to chiral centers False

4) The Hammond Postulate states that entropy is inverted at a neutral chiral cation False

5) A typical C=C bond length is around 1.3 x 10⁻² m False

6) For X chiral centers, there are X² maximum possible stereoisomers False

7) The change in Gibbs free energy can be expressed as ΔG = ΔH — TΔS True

8) HO⁻ is a stronger base than H₂O True

9) Increasing the reaction temperature encourages elimination reactions relative to substitution reactions True

10) Organometallic reagents have a metal connected to a carbon True

Define the following terms (8pts)

11) Nucleophile A two electron donor.

12) Lewis Acid A two electron acceptor.

13) Meso compound An achiral compound with chiral centers.

14) Kinetics The study of reaction rates.
15) Name the classes of compound that the following molecules belong to (E.g. alkane, amide, etc). (20pts)

- Ester
- Phosphate Ester
- Carboxylic Acid
- Alkyne
- Alkyl Peroxide
- Ether
- Alcohol
- Ketone
- Acid Chloride
- Peracetic Acid

16) (18pts) For the following molecule, calculate the number of …

- a) carbon atoms
- b) hydrogen atoms
- c) π bonds
- d) sp² hybridized carbons
- e) sp hybridized atoms
- f) halogens
- g) lone pairs (non bonding pairs) of electrons
- h) the C-O-C bond angle
- i) carbons in the ring
17) For each of the following reactions state whether the regiochemistry is \textit{Markovnikov}, \textit{Anti-Markovnikov} or \textit{Neither}. (12pts)

\begin{align*}
\text{Neither} \\
\text{A.M} \\
\text{Neither} \\
\text{M (if use Br}_2\text{/H}_2\text{O)} } \\
\text{M} \\
\text{Neither}
\end{align*}

18) In the lowest energy conformation of \textit{trans}-1,2-dimethylcyclohexane, how many axial positions are occupied by Hydrogen atoms? (6pts)

\begin{align*}
\text{6 axial Hydrogens}
\end{align*}
19) (i) Write a mechanism (i.e. curly arrows) for this E1 elimination. (8pts)

\[
\begin{array}{c}
\text{Br} \\
\text{CH}_3 \\
\text{CH}_2 \\
\text{CH}_2 \\
\text{CH}_2
\end{array}
\xrightarrow{\begin{array}{c}
\text{K}^+ \text{OCH}_3, \text{CH}_3\text{OH}
\end{array}}
\begin{array}{c}
\text{CH}_3 \\
\text{CH}_2 \\
\text{CH}_2 \\
\text{CH}_2
\end{array}
\]

\[= \text{CATION}\]

(ii) Is the above product Hoffman or Saytzeff? (3pts)

(iii) There is also another (minor) alkene product that is formed from this elimination, draw this product. (3pts)

\[
\begin{array}{c}
\text{CH}_3 \\
\text{CH}_2 \\
\text{CH}_2 \\
\text{CH}_2
\end{array}
\]

20) Draw the following molecules: (10pts)

3-Fluoro-1-pentyne

cis-2-Methylcyclobutanol
21) Explain (including curly arrows) why in this electrophilic addition reaction, none of product A is generated, and product B is formed exclusively. (10pts)

22) Name the following compounds in IUPAC format. (8pts)

(a) OH
(b) \(\text{CH}_2\text{CH}_2\text{CH}_2\text{H} \rightarrow \text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \)

1-propanol
(E)-1-bromo-4-octene
23) Assign R or S to each chiral center in these molecules. (12pts)

(a) 

(b) 

(c) 

(d) 

24) What is the name of this type of Projection? (2pts)

Newman

(b) What is meant by the term diastereomer? (2pts)

A stereoisomer which is not an enantiomer

c) Draw two molecules that are structural isomers (5pts)

Cults
25) Circle the most stable member of each threesome. (12pts)

(a) 

(b) 

(c) 

(d) 

(e) 

(f)
26) Give the reagents or products for 6 of the 8 following reactions. (18pts)

(a) \[
\begin{align*}
\text{CH}_3\text{CH}_2 & -\text{CH}_3 \\
& \text{DBH}_3 \\
& \text{H}_2\text{O}_2, \text{NaOH}
\end{align*}
\] \[
\text{CH}_3\text{CH}_2 \quad \text{CH}_3
\]

(b) \[
\text{H}_3\text{C} - \text{C} = \text{C} - \text{H} \quad \text{NaNH}_2 \quad \text{H}_2\text{C} - \text{C} = \text{C} - \text{Na}^+
\]

(c) \[
\text{\text{H}_3\text{C}} \quad \text{\text{H}_2\text{O}}_2
\]

(d) \[
\text{\text{H}_3\text{C}} \quad \text{\text{H}_2\text{O}}_2
\]

(e) \[
\text{H}_3\text{C} - \text{C} = \text{C} - \text{H} \quad \text{Excess HCl}
\]

(f) \[
\text{H}_3\text{C} - \text{C} = \text{C} - \text{H} \quad \text{HgSO}_4, \text{H}_2\text{SO}_4, \text{H}_2\text{O}
\]

(g) \[
\text{H}_3\text{C} - \text{C} = \text{C} - \text{CH}_3 \quad \text{H}_2 \quad \text{Lindlar's Catalyst}
\]

(h) \[
\text{\text{H}_3\text{C}} \quad \text{\text{H}_2\text{O}}_2
\]
27) Give the products in 5 of the 6 following transformations. (15pts)

28) Draw curly arrows to show the mechanism of the following $S_Ni_1$ reaction. (8pts)