
Instructor: Paul J. Bracher

Exam #1

Tuesday, July 8th, 2014
8:00–9:15 a.m. (in class)

Student Name (Printed) 
Student Signature

Instructions & Scoring

- Please write your answers on the official answer sheet. No answers marked in this booklet will be graded.
- You may use a single sheet of notes and a model kit. You may not collaborate with others.
- Your exam answer sheet may be photocopied.

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This exam covers Chapters 15, 16, 17, and 18 in Janice Smith’s *Organic Chemistry, 4th ed.*
Problem I. Multiple choice (35 points total; +5 points for a correct answer, +2 points for an answer intentionally left blank, and 0 points for an incorrect answer). For each question, select the best answer of the choices given. Write the answer, legibly, in the space provided on the answer sheet.

(1) The yield of the following reaction will be poor for what reason(s)?

\[
\begin{array}{c}
\text{Cl} \\
\text{CH}_3
\end{array}
\xrightarrow{\text{AlCl}_3}
\begin{array}{c}
\text{H}_3\text{C} \\
\text{O} \\
\text{H}_2\text{C} \\
\text{O} \\
\text{NH}_2
\end{array}
\]

(a) amino groups are meta directors, not ortho/para directors
(b) these conditions are prone to multiple substitutions (overalkylation)
(c) the amino group will form a complex with AlCl₃
(d) aniline is a poor nucleophile for electrophilic aromatic substitutions
(e) all of the above

(2) Which of the following adjectives best describes the electronic structure of the methyltropylium cation (A)?

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

(a) aromatic
(b) antiaromatic
(c) nonaromatic
(d) pseudoaromatic
(e) radical
(3) ___________ Which of the following statements about compound B is true?

![Chemical structure](image)

(a) the compound is aromatic
(b) the compound is antiaromatic
(c) the nitrogen atom is $sp^2$ hybridized
(d) the nitrogen atom is $sp^3$ hybridized
(e) none of the above statements is true

(4) ___________ Which of the following structures is not a valid resonance form to describe the intermediate formed when phenol reacts with Br₂.

![Chemical structures](image)

(a) ![Chemical structure](image)
(b) ![Chemical structure](image)
(c) ![Chemical structure](image)
(d) ![Chemical structure](image)
(e) all four of these structures are valid
(5) __________  Which of the following statements about the following reaction is true?

\[
\text{[Structured reaction diagram]}\]

(a) product \textbf{C} will be produced in higher yield than \textbf{D}
(b) the rate of the reaction would increase if 2-methylcyclopentadiene were used in place of cyclopentadiene
(c) the reaction produces another enantiomer of \textbf{C} that is not shown
(d) all of the above
(e) none of the above

(6) __________  What is the major product expected of the sequence of reactions below?

\[
\begin{align*}
\text{[Sequence of reactions diagram]} \\
\end{align*}
\]

(a) \[
\text{(a)}
\]
(b) \[
\text{(b)}
\]
(c) \[
\text{(c)}
\]
(d) \[
\text{(d)}
\]
(e) \[
\text{(e)}
\]
(7) __________ Which of the following statements accurately describes the bonding in 1-butene (E)?

(a) the C2–C3 bond is shorter than the C3–C4 bond
(b) the C3 carbon is \( sp^3 \)-hybridized
(c) the \( \pi^* \) molecular orbital of the compound is empty
(d) all of the above
(e) none of the above

Problem II. Mechanism (24 points).

(1) (16 points) Draw a sensible mechanism for the following reaction. Remember to use proper “curved arrow notation” to account for the movement of electrons in the making and breaking of bonds. Show all significant resonance forms that account for the stability of the intermediates in the reaction.
(2) (8 points) Will the reaction above become faster or slower if the fluorine atom is replaced with bromine? Explain why in no more than two sentences.

Problem III. Reactions (21 points). The following chemical reactions are missing their starting materials, products, or reagents. Write the missing compounds into the empty boxes below, as appropriate. For missing products, draw the single organic product that you expect to be produced in the highest yield among all of the possibilities. In some cases, there will be more than one correct answer that will merit full credit.

(1) (6 points)

(2) (7 points)

(3) (8 points)
**Problem IV.** Synthesis (20 points). Design an efficient synthesis of compound F from the indicated starting materials and any other reagents you wish. Assume that your boss has a passionate hatred of overalkylation and insists that under no circumstances are you allowed to use Friedel–Crafts alkylation reactions (but acylations are OK). Note: You can accomplish this synthesis in five steps.

![Diagram](image)

F