1. What is the IUPAC name of the molecule shown below? (6 points, 6 minutes)

\[
\text{4, 5-dimethyl-} \\
\text{1, 3, 5, 7-octatetraene}
\]

2a. How many chiral centers are present in the molecule shown below? (7 points, 9 minutes)
2b. Label each chiral center as R or S.
2c. Is the overall molecule chiral? Yes
3. Draw both chair conformations of the molecule shown below and circle the one that is lower in energy. (7 points, 9 minutes)

![Molecule Diagram]

4. How could infra-red spectroscopy be used to distinguish between the following two compounds? (4 points, 4 minutes)

![Compound Diagram]

broad peak at ~ 3300 cm⁻¹

sharp, strong peak at ~ 1700 cm⁻¹
5. Show the **major** product or products of each of the following reactions. Do not show **minor** products. Be sure to show proper stereochemistry. (4 points each, 5 minutes each)

**a.**

\[ \text{CH}_2\text{C(OH)}_2 \xrightarrow{\text{HS--S--SH, H}^+} \]

**b.**

\[ \text{CH}_2\text{C(OH)}_2 \xrightarrow{\text{excess chromic acid}} \]

\[ (\text{H}_2\text{CrO}_4) \]

**c.**

\[ \text{CH}_2\text{BrCH}_2\text{F} \xrightarrow{\text{MeOH, cold}} \]

\[ \text{SN}_1 \]

\[ \text{or} \]

\[ \text{or} \]

\[ \text{or} \]
Give the reagent or reagents necessary to accomplish each of the following transformations. Number each step so it is clear when reagents must be added together or separately. Do not show intermediates. (4 points each, 5 minutes each)

**a.**
\[
\begin{align*}
1. \text{Br}_2 & \quad \rightarrow \quad \text{Br} \\
2. \text{NH}_2^- & \quad \text{(at least 2 equiv)} \\
3. \text{HBr} & \quad \text{or} \\
1. \text{Br}_2 & \quad 2. \text{NH}_2^- \quad 1 \text{ equiv}
\end{align*}
\]

**Ch. 9 b.**
\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{OH} & \quad \rightarrow \quad \text{OCH}_2\text{CH}_3 \\
\text{ORs} & \quad \text{(SN1 conditions)}
\end{align*}
\]

**Ch. 11 c.**
\[
\begin{align*}
1. \text{RCO}_2\text{H} & \quad \rightarrow \quad \text{O} \\
2. \text{H}_2\text{O, with } \text{OH}^- & \\
3. \text{H}_3\text{O}^+ & \quad \text{O}
\end{align*}
\]

**NOTE:**

- OTs is a good leaving group.

**Omit:**

- Ch. 11 c.
Give the reagent or reagents necessary to accomplish each of the following synthetic transformations. Any needed carbon-based reagents are allowed. **Show all intermediates.**

(6 points each, 7 minutes each)

1. **OMIT**
   - CH1.16
   - ![Chemical Structure](image1)

2. **OMIT**
   - CH1.16
   - ![Chemical Structure](image2)

3. **OMIT**
   - CH1.16
   - ![Chemical Structure](image3)
Show the mechanism for both steps of the following reaction. (18 points, 22 minutes)
Determine the structure of the compound whose $^1$H NMR spectrum is shown below. You must show your work in order to receive credit for your answer. (8 points, 10 minutes)
10%. Determine the structure of the compound whose $^1$H NMR spectrum is shown below. You must show your work in order to receive credit for your answer. (8 points, 10 minutes)