Be certain that your examination has eleven (11) pages including this one.

Put your name on each page of this examination booklet.

By putting your name on this examination booklet you agree to abide by California State University, Northridge policies of academic honesty and integrity.
1. (25 points)

For each of the following five (5) questions draw the structure of the expected major organic product. If relevant, specify the absolute and/or relative stereochemistry of the product.

A. 

B. 

C. 

D. 

E. 

2. (25 points)

For each of the following five (5) questions denote the reagent or reagents necessary to effect the transformation shown. More than one step may be required.

A.

B.

C.

D.

E.
3. (20 points)

Draw a specific example of each of the following:

A. any prostaglandin:

B. any chain-growth polymer:

C. any terpene:

D. any naturally-occurring wax:

E. any naturally-occurring aldotetrose:

F. any naturally-occurring phospholipid:

G. any naturally-occurring neutral α-amino acid (zwitterionic form):

H. any naturally-occurring unsaturated triacylglycerol:

I. any steroid:

J. any dipeptide:
4. (25 points)

The following transformation is a step in Fraser-Reid's synthesis of \((\pm)-\text{exo-brevicomin}\) from D-glucose. Draw the mechanism of this reaction, using the curved-arrow notation to indicate the reorganization of electron density. Show all intermediates and denote all lone pairs, formal charges and countercharges where appropriate.

\[
\begin{align*}
\text{H}_2\text{C} & \xrightarrow{\text{Bn} \equiv \text{CH}_2\text{Ph}} \text{CH}_3 \quad + \quad \text{H}_2\text{O} \quad (\text{excess}) \\
\text{H}_3\text{C} & \begin{array}{c}
\text{O} \\
\text{O}
\end{array} \\
\text{H}_2\text{C} & \xrightarrow{} \text{CH}_3 \\
\text{H}_2\text{C} & \begin{array}{c}
\text{O} \\
\text{O}
\end{array} \\
\text{H}_3\text{C} & \begin{array}{c}
\text{O} \\
\text{O}
\end{array}
\end{align*}
\]
5. (25 points)

A critical step in terpene and steroid biosynthesis is the isomerization of isopentenyl pyrophosphate to \( \gamma,\gamma' \)-dimethylallyl pyrophosphate, a process catalyzed by the enzyme, isomerase. Assuming that an acidic amino acid unit (either an aspartic acid or a glutamic acid) of isomerase is involved, draw the mechanism of this reaction, using the curved-arrow notation to indicate the reorganization of electron density. Show all intermediates and denote all lone pairs, formal charges and countercharges where appropriate.
6. (25 points)

Design a synthesis of the following unsaturated ether from benzaldehyde, triphenyl phosphine and mono- or difunctional organic starting materials of five carbons or less. Use any inorganic and organic reagents that you deem necessary. Show all reagents and stable synthetic intermediate compounds.

\[
\text{Ph} = \text{O} - \text{CH}_3 \quad \text{from: Ph}_2\text{H and Ph}_3\text{P}
\]
7. (30 points)

Answer the following three (3) questions precisely and succinctly.

A. Why is the Merrifield solid-phase peptide synthesis so useful? What is one limitation of the process?

B. Describe what occurs during a "lock-and-key" enzyme-substrate binding. Draw simple schematics to illustrate your answer.

C. Why do naturally-occurring fatty acids contain an even number of carbons?
8. (25 points)

The infrared, $^1$H NMR and $^{13}$C NMR spectra of compound A ($C_9H_{10}O$) are shown below. Clearly assign all the resonances that you can identify with certainty and draw the structure of compound A. (Correlation tables are included separately.)

The infrared spectrum is unavailable due to copyright considerations.
8. (cont.)

The $^1$H NMR and $^{13}$C NMR spectra are unavailable due to copyright considerations.
8. (cont.)

Infrared absorption assignments:

<table>
<thead>
<tr>
<th>frequency (cm⁻¹)</th>
<th>functional group</th>
<th>type of vibration</th>
</tr>
</thead>
</table>

1H NMR assignments:

<table>
<thead>
<tr>
<th>chemical shift (ppm)</th>
<th>assignment</th>
<th>explanation of multiplicity</th>
</tr>
</thead>
</table>

13C NMR assignments:

<table>
<thead>
<tr>
<th>chemical shift (ppm)</th>
<th>assignment</th>
<th>explanation of multiplicity</th>
</tr>
</thead>
</table>

structure of compound A:

Congratulations!

1 /25
2 /25
3 /20
4 /25
5 /25
6 /25
7 /30
8 /25

Total: /200