

Chemistry 333

Final Examination

December 14, 1998

Professor Charonnat

Name: _____

Be certain that your examination has ten (10) pages including this one.

Put your name on **each** page of this examination booklet.

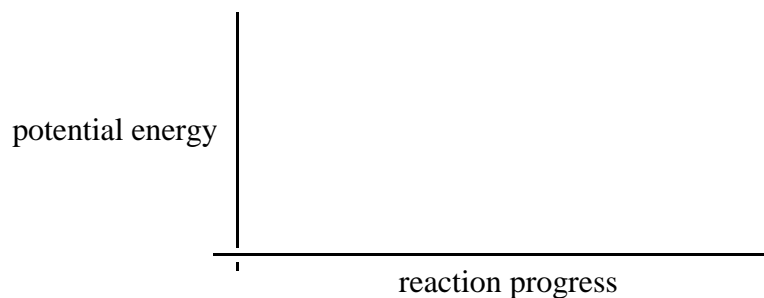
By putting your name on this examination booklet you agree to abide by California State University, Northridge policies of academic honesty and integrity.

Name: _____

1. (20 points)

Draw reaction coordinate diagrams for both of the following two (2) examples. Annotate the diagrams with appropriate labels: starting materials (s), transition states (ts), intermediates (int), products (p), activation energies (E_a) and overall standard heat of reaction (ΔH°).

A. an S_N2 reaction with a favorable equilibrium



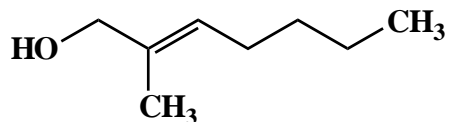
B. an $E1$ reaction with a favorable equilibrium



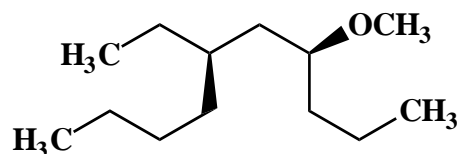
2. (20 points)

Use IUPAC nomenclature to write the systematic name for both of the following two (2) compounds.

A.



B.

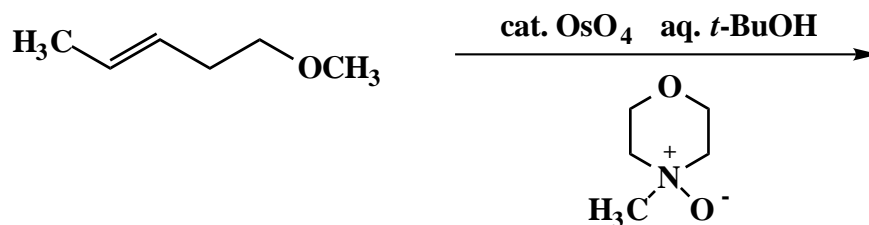


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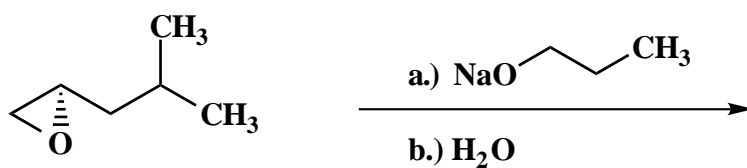
3. (25 points)

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

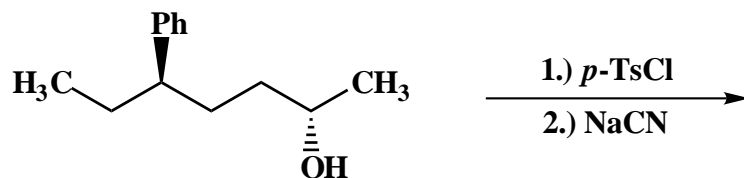
A.



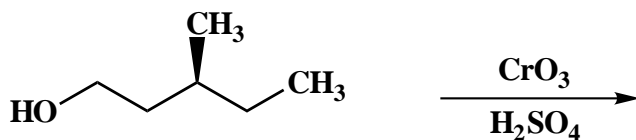
B.



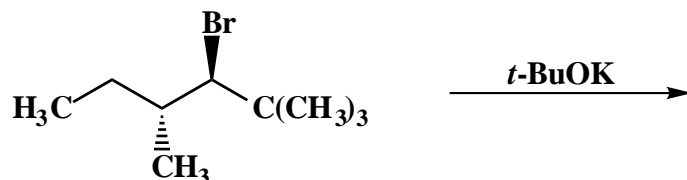
C.



D.



E.



Name: _____

4. (20 points)

For each of the following five (5) questions, circle the number that corresponds to the correct answer.

A. In the ^1H NMR spectrum of 4-heptanol, the carbinol proton will appear as a

1. triplet of triplets.
2. quintet.
3. doublet of quartets.

B. Fourier-transform NMR spectrometers

1. scan magnetic field sequentially while holding the frequency constant.
2. scan frequency sequentially while holding the magnetic field constant.
3. pulse all frequencies simultaneously while holding the magnetic field constant.

C. The mass spectrum of a compound has molecular ion signals at 122 and 124, with equal relative abundances. From this information, one can be fairly certain that the compound contains

1. chlorine.
2. bromine.
3. sulfur.

D. Other factors being equal, increased bond strength causes the vibrational frequency to be

1. higher.
2. the same.
3. lower.

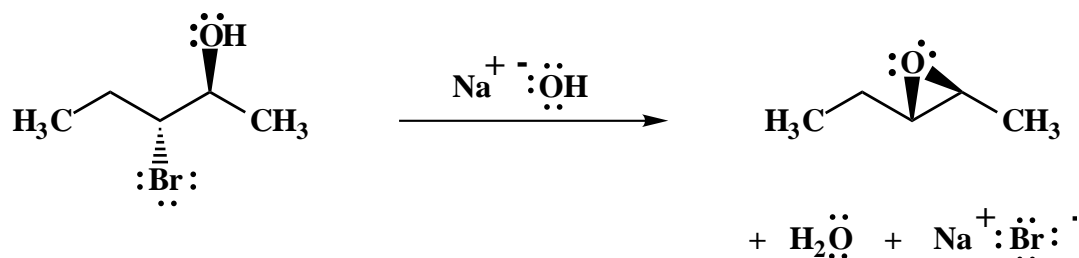
E. Epoxides are reactive primarily due to

1. torsional strain.
2. steric strain.
3. angle strain.

Name: _____

5. (15 points)

Draw the mechanism of the following reaction, using the curved-arrow notation to indicate the reorganization of electron density. Show **all** intermediates and denote **all** lone pairs and countercharges. Explain concisely why only the stereoisomer shown is formed.



6. (25 points)

Use Newman projections to draw the three possible eclipsed and the three possible staggered conformations of 2-methylbutane that are formed by rotation about the C2–C3 bond. Circle the two least stable conformations. Put a star next to the two most stable conformations.

Name: _____

7. (30 points)

Answer the following three (3) questions precisely, succinctly and with correct grammar.

A. Why are ^1H NMR spectra integrated? Why are ^{13}C NMR spectra not integrated?

B. There usually are a number of signals in a mass spectrum that are at smaller m/z values than the molecular ion's signal. What is the chemical basis for this fact?

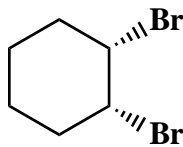
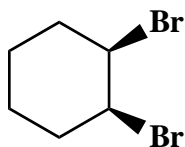
C. The "harmonic oscillator" is a mathematical model for molecular vibrations. In this model, two objects are connected by a spring with zero mass. Why is this model a numerically valid approximation for molecular vibrations?

Name: _____

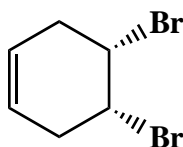
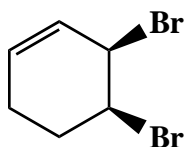
8. (20 points)

State the structural relationship between each of the following four (4) pairs of compounds (enantiomers, diastereomers, identical or structural isomers).

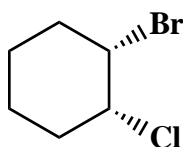
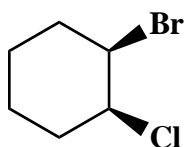
A.



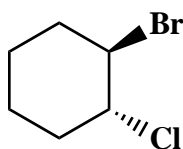
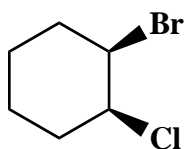
B.



C.



D.



Name: _____

9. (25 points)

The infrared, ^1H NMR and ^{13}C NMR (broadband ^1H decoupled) spectra of compound A ($\text{C}_5\text{H}_{12}\text{O}$) 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.

Name: _____

9. (continued)

The ^1H NMR and ^{13}C NMR spectra are unavailable due to copyright considerations.

Name: _____

9. (continued)

Infrared absorption assignments:

wave number (cm ⁻¹)	functional group	type of vibration (stretch or bend)
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¹H NMR assignments:

chemical shift (ppm)	assignment	explanation of multiplicity
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¹³C NMR assignments:

chemical shift (ppm)	assignment	explanation of multiplicity
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structure of compound A:

Congratulations! Happy Holidays!

1	/20
2	/20
3	/25
4	/20
5	/15
6	/25
7	/30
8	/20
9	/25
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Total:	/200