

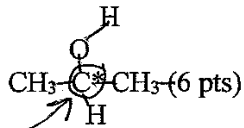
Sign Name Key Print Name _____
 (5 pt name above print & sign punitive) (100 pts, 7 pages, periodic table, IR/NMR chart)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. Telling me during the exam where to find the answer does not qualify because I will just vaguely remember someone telling me something during the exam not which one of 70 OCI Lab and 90 OCII Lab students told me what to grade on what page of the exam.)

You will do the multiple choice by circling the letter on this exam itself. NO PARTIAL CREDIT ON MULTIPLE CHOICE. NO SCANTRON – not enough multiple choice questions. The multiple choice questions are mixed in between fill in the blank and long answer questions.

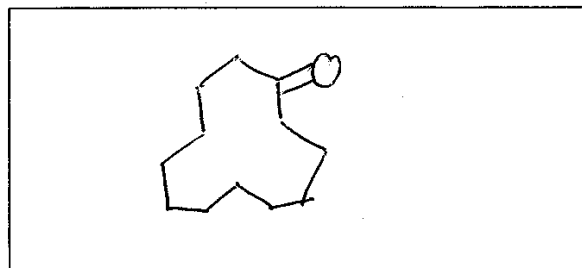
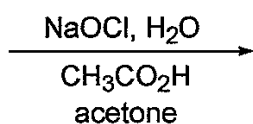
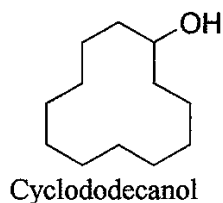
Please READ and FOLLOW directions. (ex: don't give me 5 structures if I only ask for one or you will lose points on this exam by **RUNNING OUT OF TIME**) **TIMED REACTION**

Oxidation of Cyclododecanol (32 pts)

1. Multiple Choice: Oxidation state of the C with * in the following molecule is:  (6 pts)

- (a) $O(-1)(2) + C(2)(0) + OS = \text{zero}, OS = +2$
 (b) $O(-1)(1) + C(2)(0) + H(+1)(1) + OS = \text{zero}, OS = \text{zero}$
 (c) $O(-2)(1) + C(2)(0) + H(+1)(1) + OS = \text{zero}, OS = +1$
 (d) All of the above are false.

2. Complete the following reaction by giving the product which you made during this lab. (6 pts)



with
 $=O-H$
 Ok

3. Multiple Choice: In the reaction above as you ran the experiment in the lab. (6 pts)

(a) Limiting reagent is Na OCl (bleach)

(b) Limiting reagent is the cyclododecanol.

(c) Limiting reagent is the product.

(d) You do the reaction with equal molar amounts of alcohol and bleach.

(e) All above statements are false.

you added excess
bleach

4. What is the purpose of Na_2SO_4 during the workup in almost all organic reactions? (8 pts)

Na_2SO_4 soaks up H_2O so that your

organic product comes out of organic
solution water free, H_2O is hard to
rotovap off so if H_2O is still

left you get a goopy wet product

impure to

BA - 6

Always
4

only have
water
organic

5. Multiple Choice: In the reaction above, using IR (6 pts)

(a) The starting material has a peak at around 3400 to 3650 cm^{-1} and the product has a peak at around 1670 to 1780 cm^{-1}

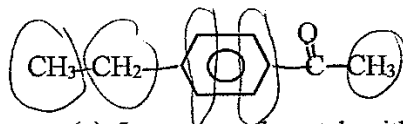
(b) The starting material has a peak at around 1670 to 1780 cm^{-1} and the product has a peak at around 3400 to 3650 cm^{-1}

(c) There is no identifiable IR peak which identifies whether the reaction goes or not so you would not use IR to check whether the reaction went or not

(d) All statements above are incorrect.

Introduction to NMR & Unknown (36 pts)

1. Multiple Choice: Given the following molecule, the number of proton NMR peaks assuming perfect separation is: (no partial credit this question) (6 pts)



(a) 5 proton peaks total with a quartet with integration 3H at around 2.0 to 2.4 ppm

(b) 4 proton peaks total with a quartet with integration 2 H at a peak around 2.4 to 2.7 ppm

(c) 5 proton peaks total with a triplet proton peak with integration 3 H at peak around 0.7 to 1.3 ppm

(d) 4 proton peaks total with a doublet at around 2.0 to 2.4 with integration of 3H

(e) All of the above are false.

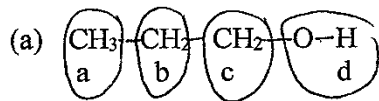
$n = 2$

$n + 1 = 3$ triplet

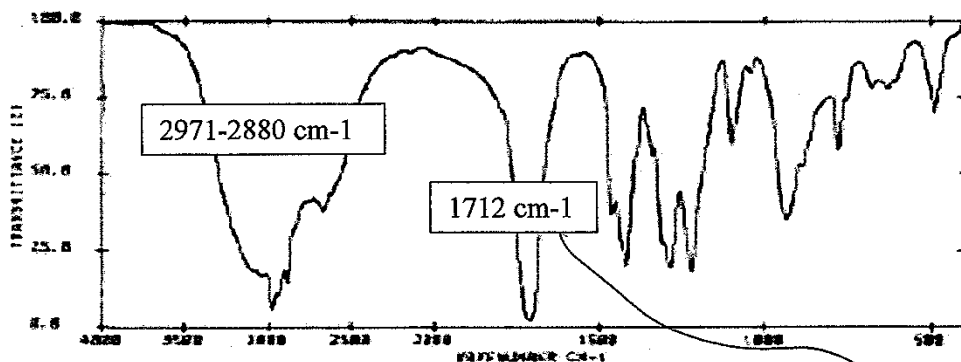
methyl

2. Given the following spectra and the following molecules which matches the spectra. (30 pts)

(Part 1) Circle one of the two molecules which you believe match the IR and NMR shown. (6 pts)



(Part 2) Explain your reasoning for your choice by explaining the IR in detail by filling in the blanks below. I have labeled the molecule but the labels do not imply how you should assign your spectra. You do not need to provide any further explanation after filling in the blanks. (12 pts, 3 pts each blank)



Functional group is _____ IR number is _____

C=O of
carboxylic acid

see 1712 ✓
 expect
 1710 cm^{-1}

Functional group is _____ IR number is _____

O-H of carboxylic
acid

2900-3100
 expect

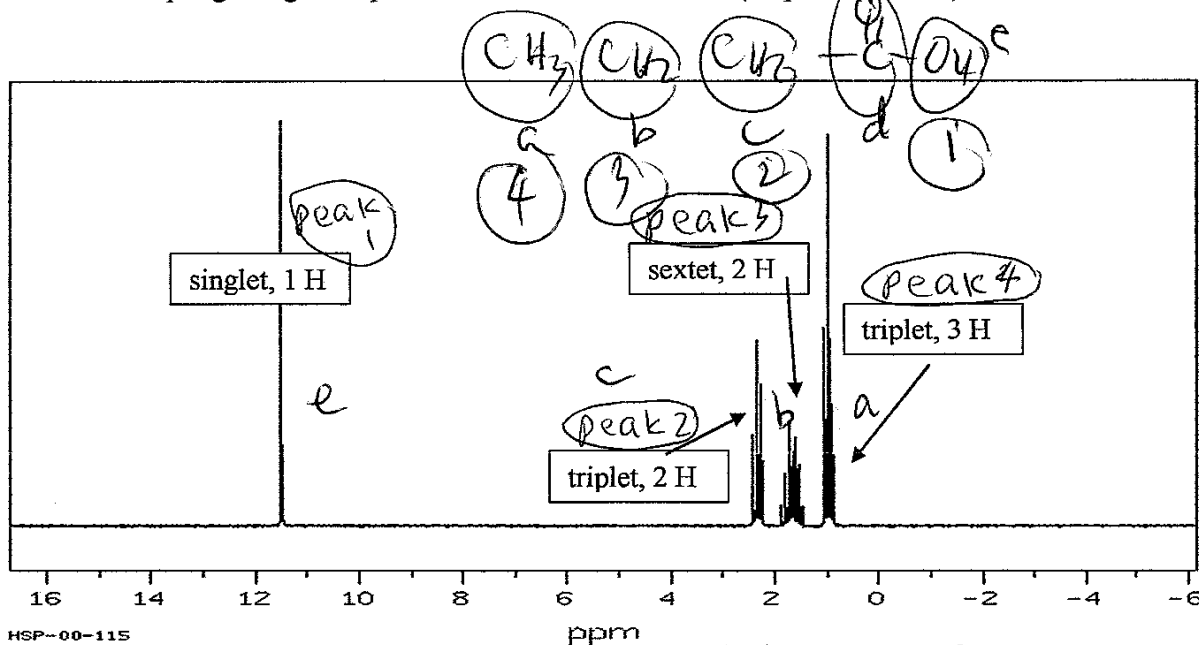
2971-2880 ✓

NSE

-1½

above ok

(Part 3) Explain your reasoning for your choice by explaining the NMR given below in detail. Because the spectra does not show the coupling and integration in enough detail, I have labeled the peaks with coupling and integration number. [example: singlet (coupling info), 1H (integration info)] I have labeled the molecule but the labels do not imply how you should assign your spectra. Explain the approximate chemical shift using the provided chart. Also explain the integration number and coupling. Show your work for the coupling using the equation $2nI + 1$ where $I = \frac{1}{2}$. (12 pts, 4 pts each)



(a) Chemical shift e - is OH - peak 1 a - peak 4

c - 2-2.6 ppm - peak 2

b - peak 3

BA - }

(b) integration

e - 1H

b - 2H

c - 2H

a - 3H

(c) coupling

(e) $n=0$, singlet - peak 1

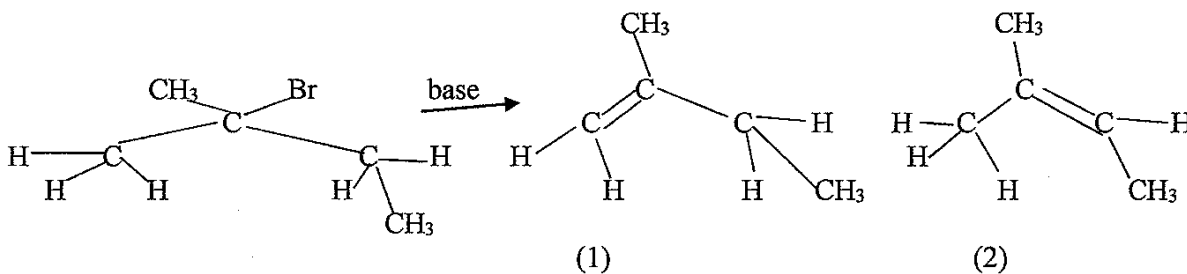
(c) $n=2$, $2(\frac{1}{2})(2) + 1 = 3$ - peak 2 - }

(b) $n=5$, $2(5)\frac{1}{2} + 1 = 6$ - peak 3

(a) $n=2$, $2(2)\frac{1}{2} + 1 = 3$ - peak 4

Elimination Reaction (E2) of Alkyl Halides (32 pts)

Given the following reaction to give diastereomeric (Zaitsev, Hoffmann) elimination product.



1. Multiple choice (based on the equation shown above) (6 pts)

- (a) Major product with KOH is (2) *small base*
- (b) Major product with KOt-Bu is (2) *bulky base*
- (c) You get equal amounts of both product (1) and product (2) no matter which base you use.
- (d) All statements above are false.

2. Explain your multiple choice answer in #1 above by explaining why you get the major product using base K O t-Bu (potassium t-butoxide) (8 pts)

bulky base major product is (1)
The transition state is very crowded to give product (2)
both KOH & t-BuOK have major product
BA to
bulky t.b. -3
Unrelated -8
major just means the product you have more of

3. Based on the labels on the equation above what would you expect for the proton NMR spectrum. (6 pts)

(a) Molecule (1) has an alkene hydrogen which is a quartet.

(b) Molecule (2) has an alkene hydrogen which is a quartet

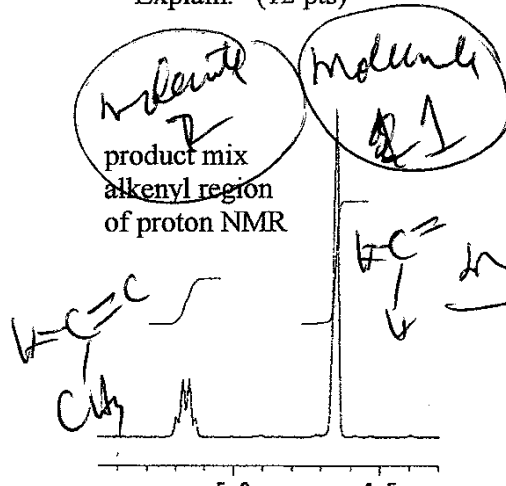
(c) Molecule (1) has an alkene hydrogen with integration of 1 hydrogen (2H)

(d) Molecule (2) has an alkene hydrogen integration of 2H (1H)

(e) All of the above are false.

4. Given the following alkenyl region of the proton NMR spectra. You would have to figure out from the coupling which is which alkenyl hydrogen. What is the ratio of alkene (1) to alkene (2)? The integration number is given below the NMR ppm number scale as 3.2 hydrogens vs 9.6 hydrogens. Explain. (12 pts)

NMR = no explain
ratio of molecule
BBA-10



molecule 1
molecule 2
3,2

$$\frac{9.6}{2}$$

4.8 : 3.2

2x 3.2 9.6
split 1/2
molecule 2
has 1H
alkene

molecule 1
has
2 alkene H

ratio
 $\frac{3.2}{9.6} = 0.33$
attempt
-6

backward
-2

alkene 1 → $\frac{9.6}{2}$ $\frac{9.6}{6.4} = 1.5$

alkene 2 → $(3.2)2$

$\frac{3.2}{3} \rightarrow \frac{9.6}{3}$
 $1 : 3.2$

$\frac{6.4}{9.6} = 0.6$