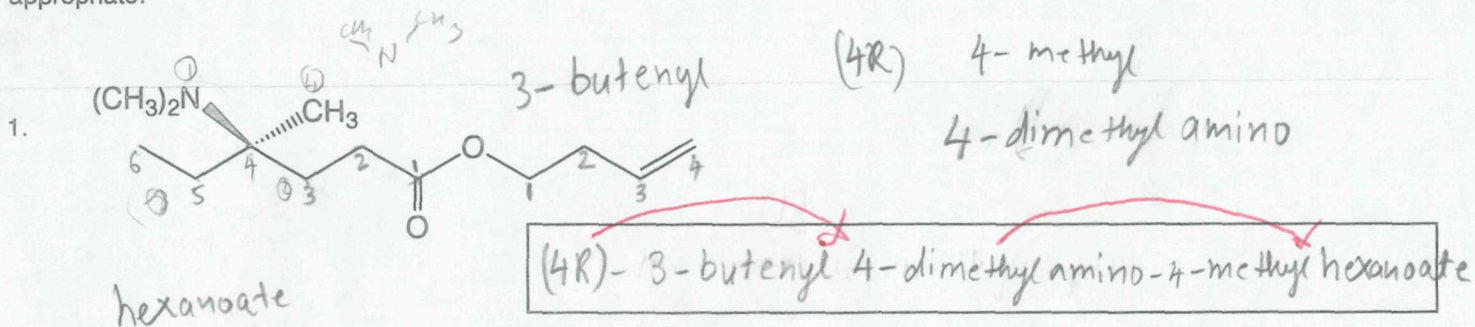


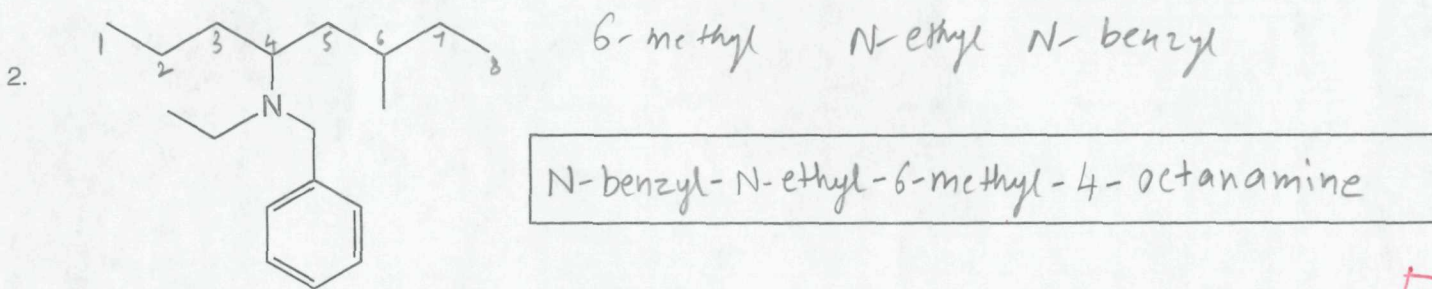
Spring 2010 - Final

A. Nomenclature: (15 points)

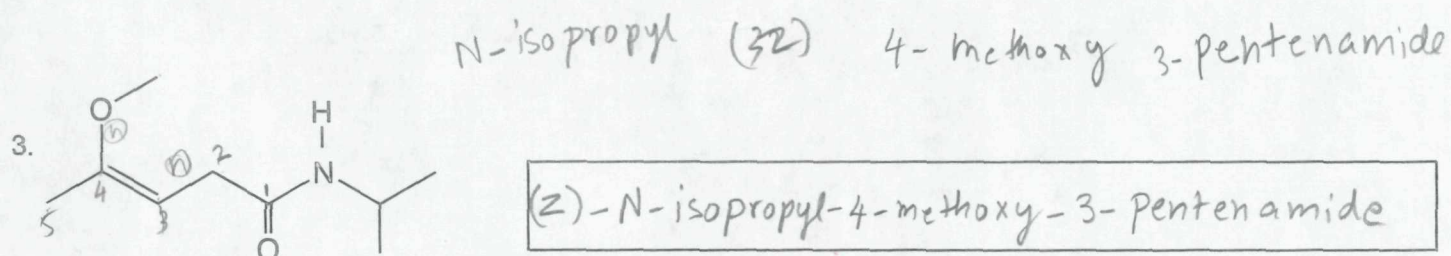
Give an acceptable IUPAC name for each of the following compounds. Be sure to indicate the stereochemistry where appropriate.



4



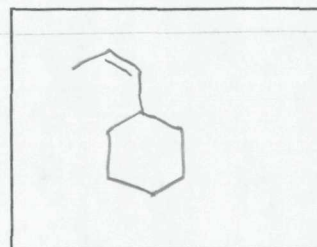
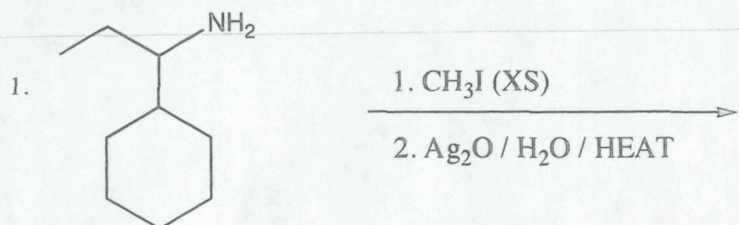
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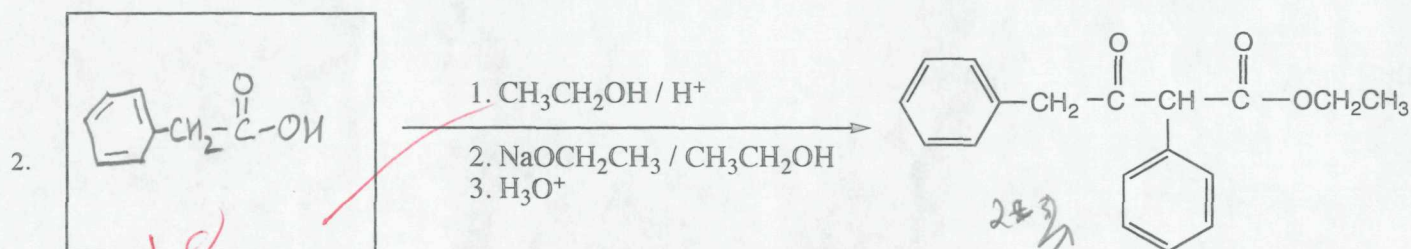
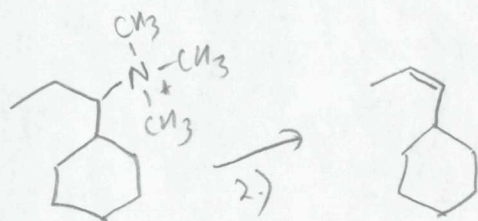
5

B. Reactions: Total = 40 points, 8 points each

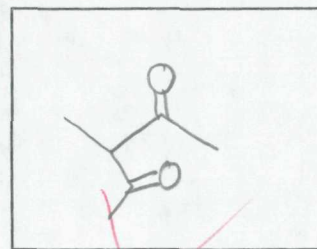
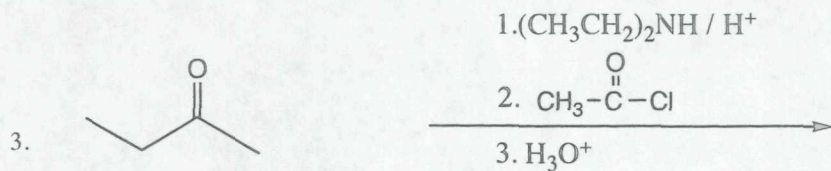
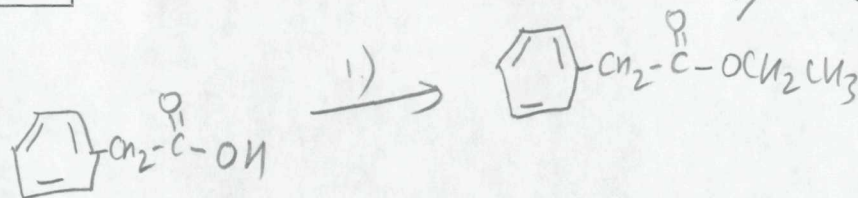
Please provide the starting material or major product in the answer box. Be sure your drawing indicates stereochemistry if applicable. Partial credit is awarded only when intermediate products in a multi-step reaction are shown below the reaction.



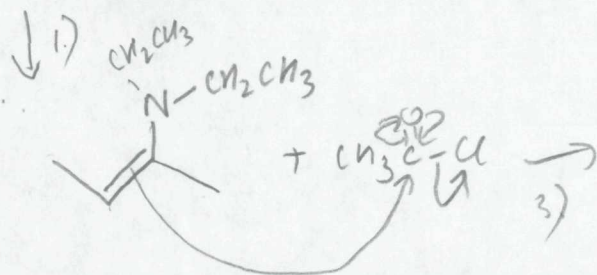
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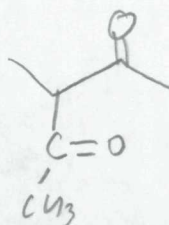
18



8

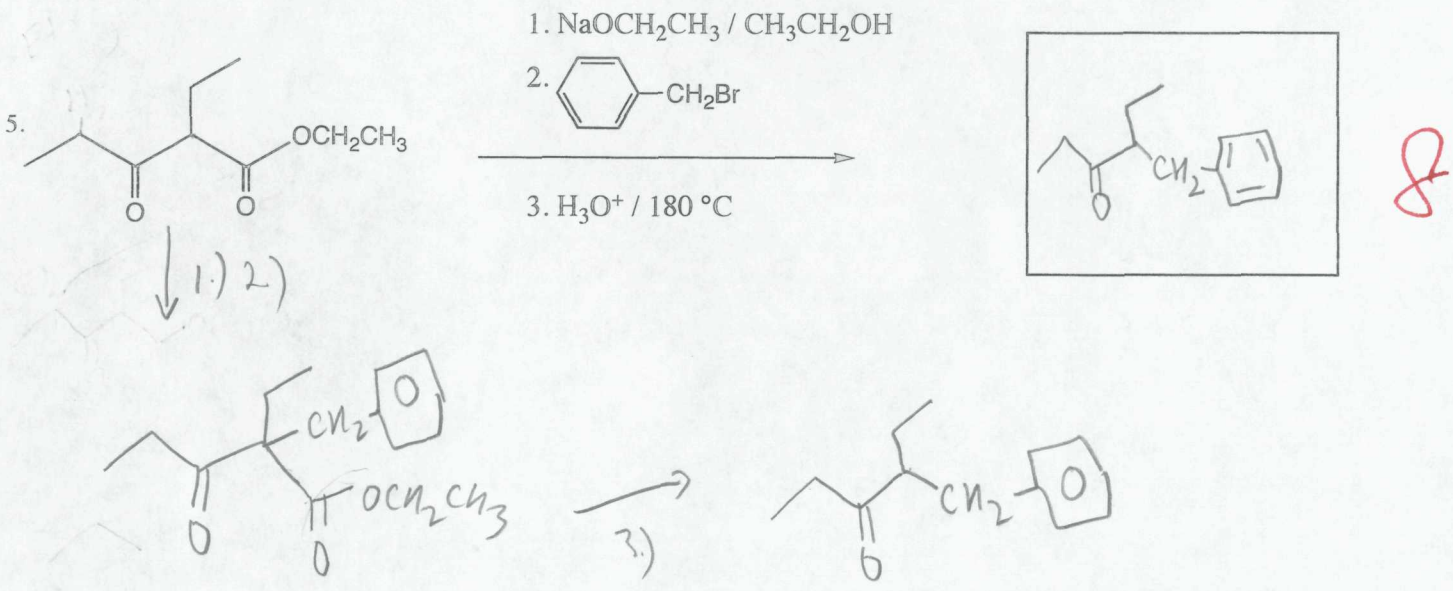
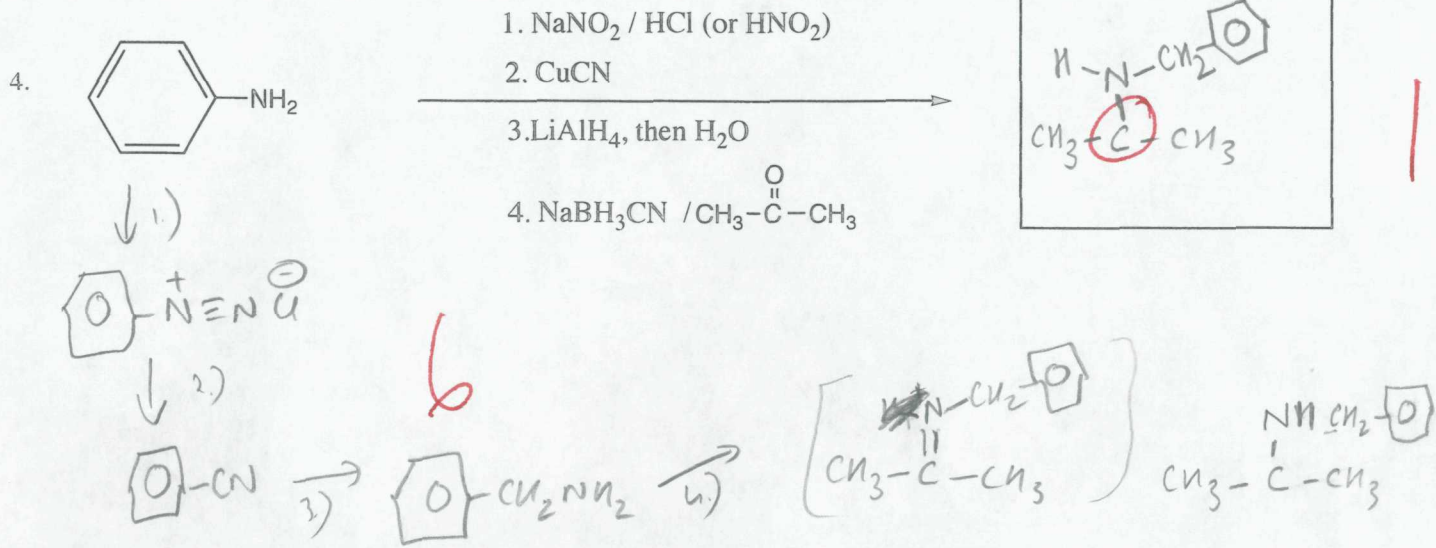


2



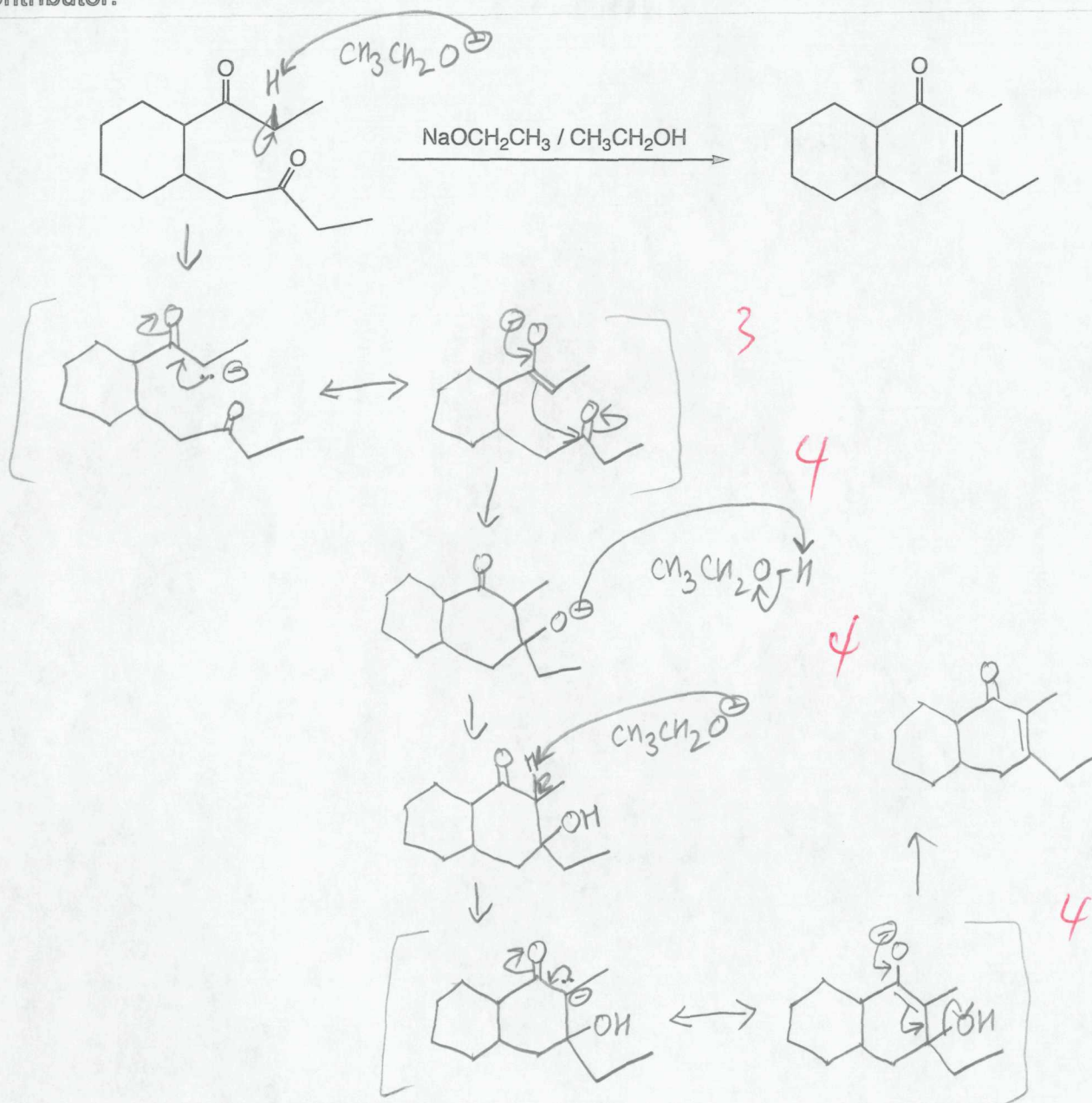
18





C. Mechanism: (15 points)

Provide a clear mechanism to explain the formation of the product. Use curved arrows to indicate "electron flow". Remember to show only one step at a time. Show all intermediates and all formal charges. When more than one resonance contributor may be drawn, be sure to draw the most stable contributor.

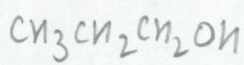
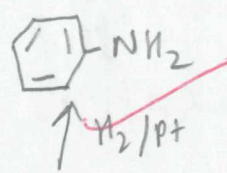
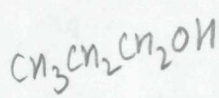
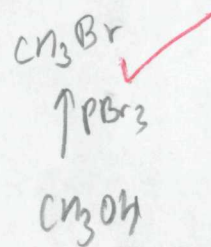
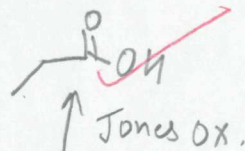
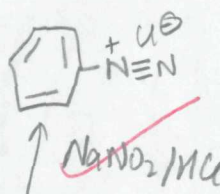
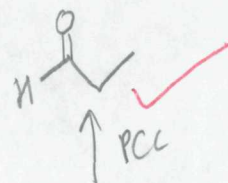
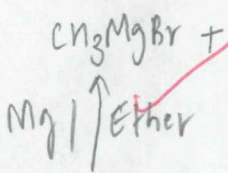
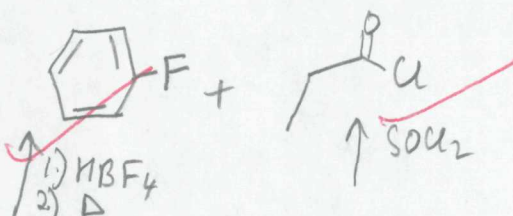
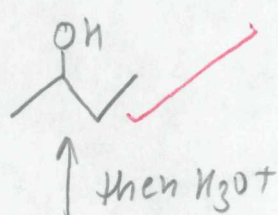
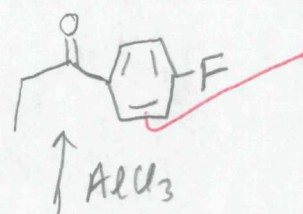
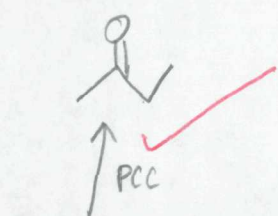
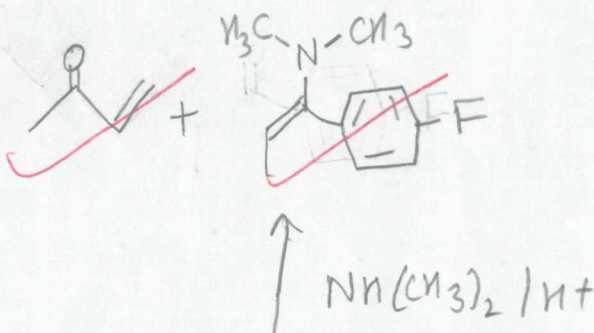
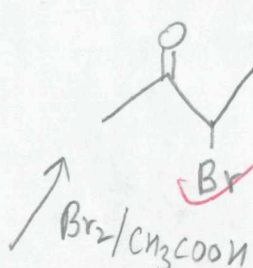
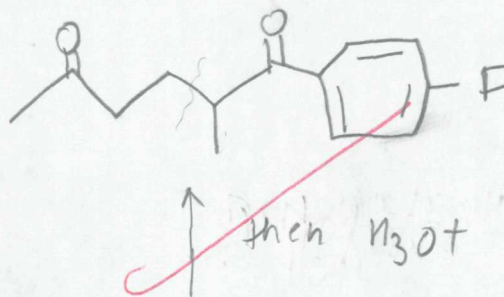
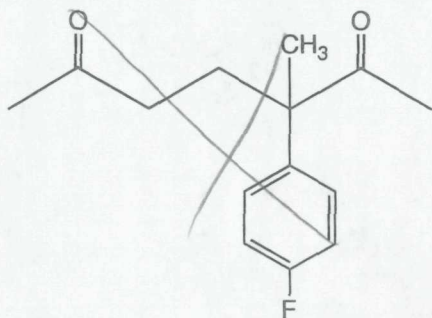




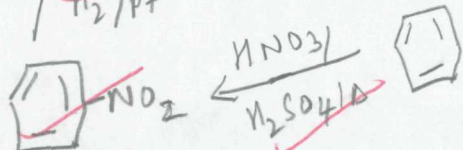
D. Synthesis: 15 Points

Synthesize the molecule below using any of the following reagents: benzene, any alkanes, alkenes, or alcohols of three carbons or less, any inorganic reagents, any oxidizing or reducing agents, and any peroxyacids.

15



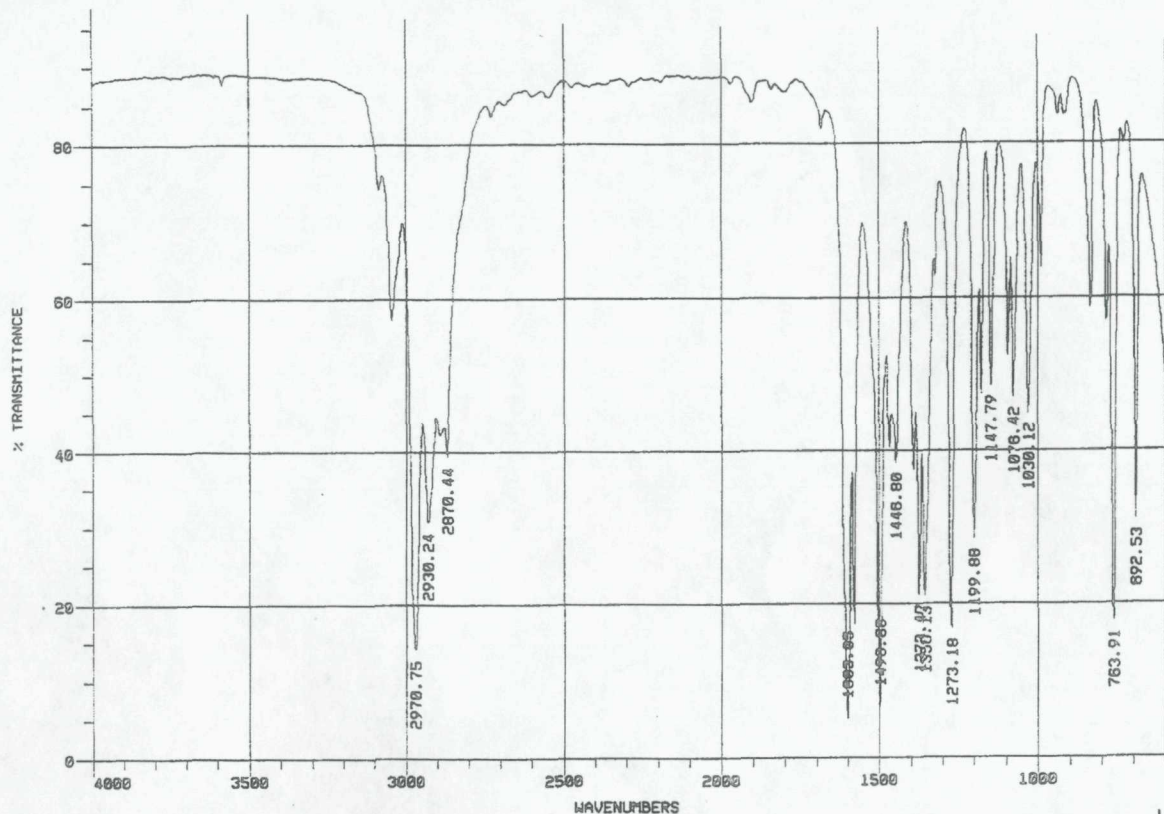
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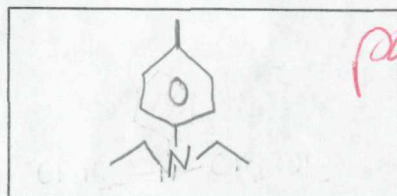
15

**E. Spectroscopy: 15 Points**

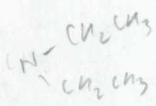
A compound with the formula  $C_{11}H_{17}N$  exhibits the IR,  $^1H$  NMR and proton decoupled  $^{13}C$  NMR spectra shown below. Please identify this compound and draw the structure in the box provided below.



answer:

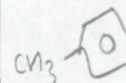


*para -*

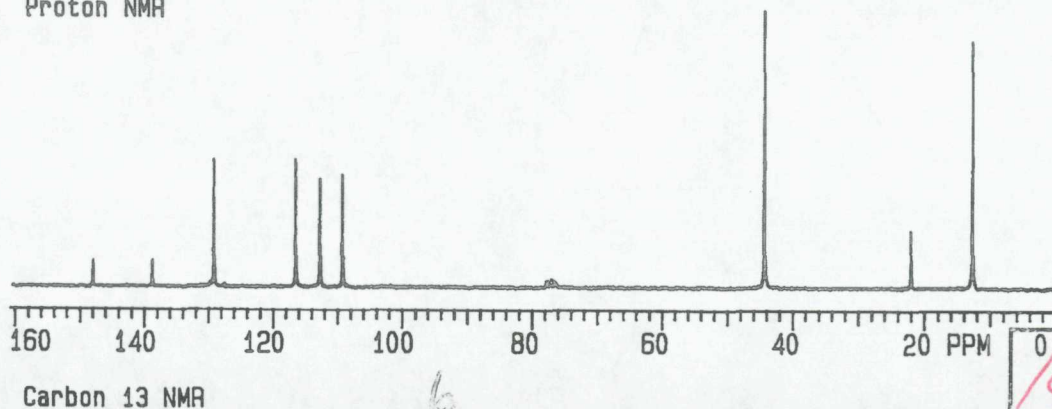
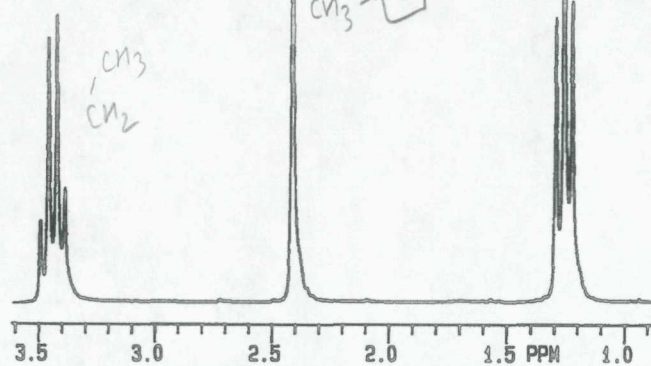
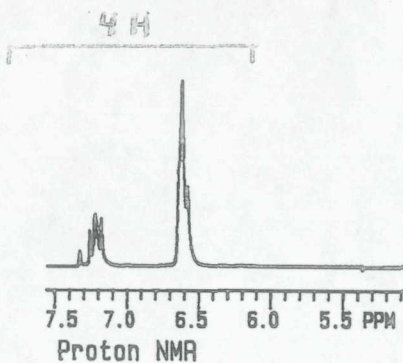
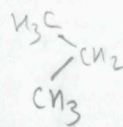


4H

3H



6H



14



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Final  
Exam

TABLE 13.3 Approximate proton chemical shifts

TYPE OF PROTON	CHEMICAL SHIFT ( $\delta$ , ppm)
1° Alkyl, RCH <sub>3</sub>	0.8-1.0
2° Alkyl, RCH <sub>2</sub> R	1.2-1.4
3° Alkyl, R <sub>3</sub> CH	1.4-1.7
Allylic, R <sub>2</sub> C=C-CH <sub>3</sub>   R	1.6-1.9
Ketone, RC(=O)CH <sub>3</sub>	2.1-2.6
Benzylic, ArCH <sub>3</sub>	2.2-2.5
Acetylenic, RC≡CH	2.5-3.1
Alkyl iodide, RCH <sub>2</sub> I	3.1-3.3
Ether, ROCH <sub>2</sub> R	3.3-3.9
Alcohol, HOCH <sub>2</sub> R	3.3-4.0
Alkyl bromide, RCH <sub>2</sub> Br	3.4-3.6
Alkyl chloride, RCH <sub>2</sub> Cl	3.6-3.8
Vinylic, R <sub>2</sub> C=CH <sub>2</sub>	4.6-5.0
Vinylic, R <sub>2</sub> C=CH   R	5.2-5.7
Aromatic, ArH	6.0-9.5
Aldehyde, RCH=O	9.5-9.6
Alcohol hydroxyl, ROH	0.5-6.0 <sup>a</sup>
Amino, R-NH <sub>2</sub>	1.0-5.0 <sup>a</sup>
Phenolic, ArOH	4.5-7.7 <sup>a</sup>
Carboxylic, RCOOH   O	10-13 <sup>a</sup>

<sup>a</sup> The chemical shifts of these protons vary in different solvents and with temperature and concentration.

TABLE 13.4 Approximate carbon-13 chemical shifts


TYPE OF CARBON ATOM	CHEMICAL SHIFT ( $\delta$ , ppm)
1° Alkyl, RCH <sub>3</sub>	0-40
2° Alkyl, RCH <sub>2</sub> R	10-50
3° Alkyl, RCHR <sub>2</sub>	15-50
Alkyl halide or amine, -C-X (X = Cl, Br, or N-)	10-65
Alcohol or ether, -C-O	50-90
Alkyne, -C≡	60-90
Alkene, >C=	100-170
Aryl, 	100-170
Nitriles, -C≡N	120-130
Amides, -C(=O)-N-	150-180
Carboxylic acids, esters, -C(=O)-O	160-185
Aldehydes, ketones, -C(=O)-	182-215

TABLE 13.2 Characteristic infrared absorptions of groups

GROUP	FREQUENCY RANGE (cm <sup>-1</sup> )	INTENSITY <sup>a</sup>
<b>A. Alkyl</b>		
C-H (stretching)	2853-2962	(m-s)
Isopropyl, -CH(CH <sub>3</sub> ) <sub>2</sub>	1380-1385 and 1365-1370	(s) (s)
<i>tert</i> -Butyl, -C(CH <sub>3</sub> ) <sub>3</sub>	1385-1395 and ~1365	(m) (s)
<b>B. Alkenyl</b>		
C-H (stretching)	3010-3095	(m)
C=C (stretching)	1620-1680	(v)
R-CH=CH <sub>2</sub>	985-1000 and 905-920	(s) (s)
R <sub>2</sub> C=CH <sub>2</sub>	880-900	(s)
<i>cis</i> -RCH=CHR	675-730	(s)
<i>trans</i> -RCH=CHR	960-975	(s)
<b>C. Alkynyl</b>		
≡C-H (stretching)	~3300	(s)
C≡C (stretching)	2100-2260	(v)
<b>D. Aromatic</b>		
Ar-H (stretching)	~3030	(v)
Aromatic substitution type (C-H out-of-plane bendings)		
Monosubstituted	690-710 and 730-770	(very s) (very s)
<i>o</i> Disubstituted	735-770	(s)
<i>m</i> Disubstituted	680-725 and 750-810	(s) (very s)
<i>p</i> Disubstituted	800-840	(very s)
<b>E. Alcohols, Phenols, and Carboxylic Acids</b>		
O-H (stretching)		
Alcohols, phenols (dilute solutions)	3590-3650	(sharp, v)
Alcohols, phenols (hydrogen bonded)	3200-3550	(broad, s)
Carboxylic acids (hydrogen bonded)	2500-3000	(broad, v)
<b>F. Aldehydes, Ketones, Esters, and Carboxylic Acids</b>		
C=O (stretching)	1630-1780	(s)
Aldehydes	1690-1740	(s)
Ketones	1680-1750	(s)
Esters	1735-1750	(s)
Carboxylic acids	1710-1780	(s)
Amides	1630-1690	(s)
<b>G. Amines</b>		
N-H	3300-3500	(m)
<b>H. Nitriles</b>		
C≡N	2220-2260	(m)

<sup>a</sup> Abbreviations: s = strong, m = medium, w = weak, v = variable, ~ = approximately.