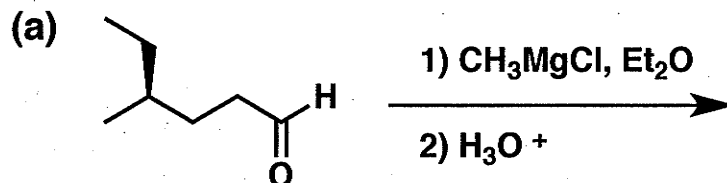
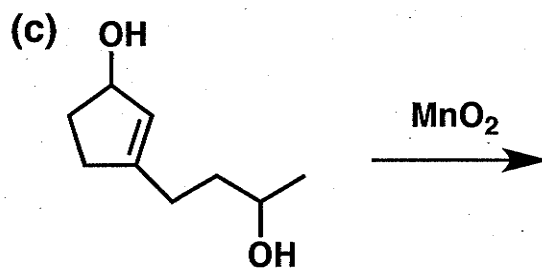
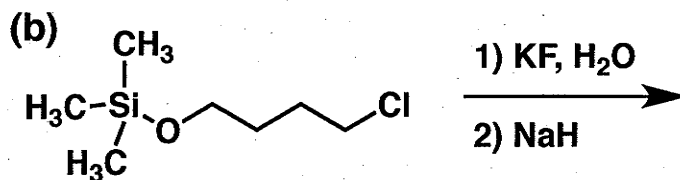


[Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit.]

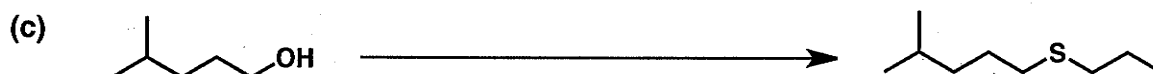
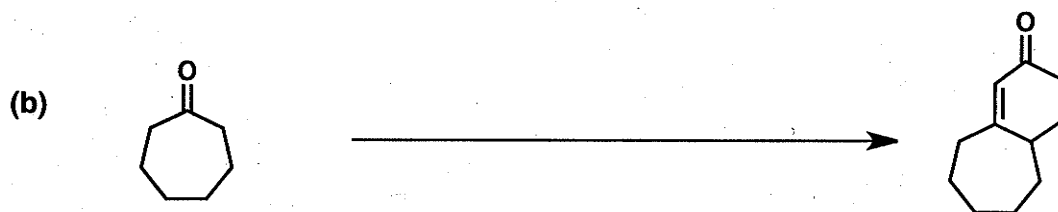
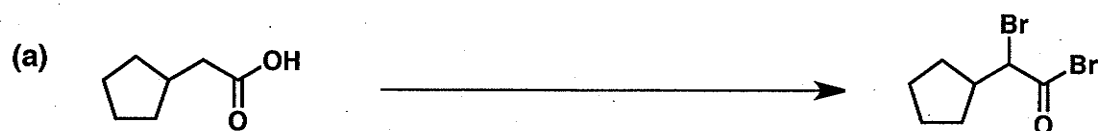
1. (20 points) Show the major product or products expected from each reaction.



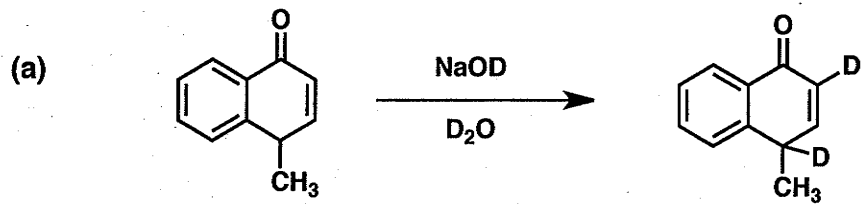
(single enantiomer)



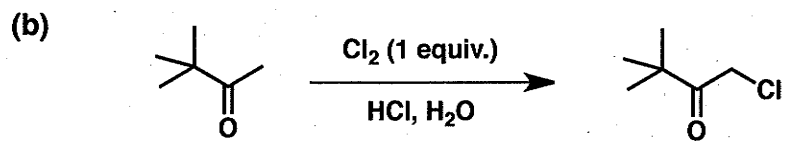
2. (18 points) Show the reagents and other organic molecules required to convert the starting material to the indicated product. Be sure to differentiate clearly between distinct steps, by using "1)," "2)," etc. over the arrow.



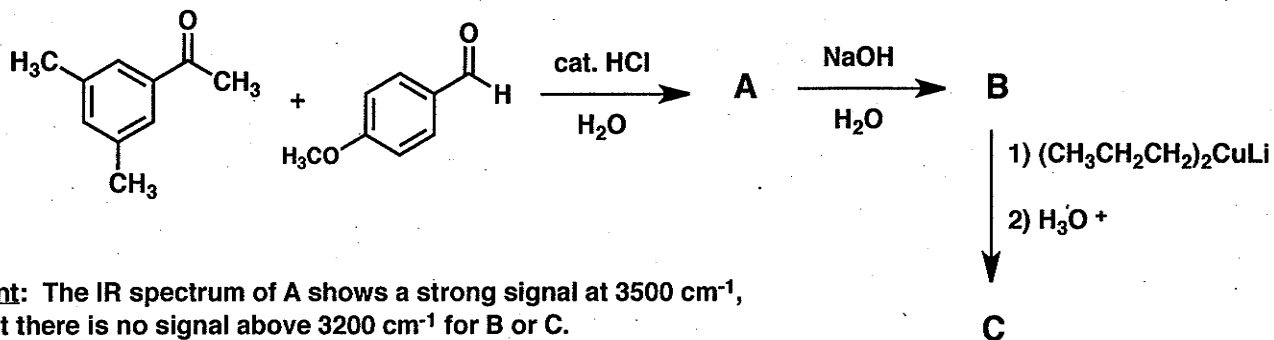
3. (20 points) Draw a complete mechanism (curved arrows) for each of the reactions shown below; be sure to show all important resonance forms.



3. (cont.)

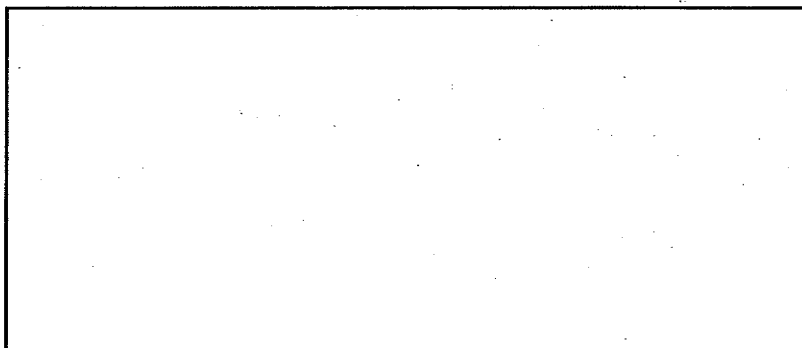


4. (18 points) Show the structure of A, B and C in the appropriate boxes. The structures you propose should be consistent with the spectroscopic data provided.

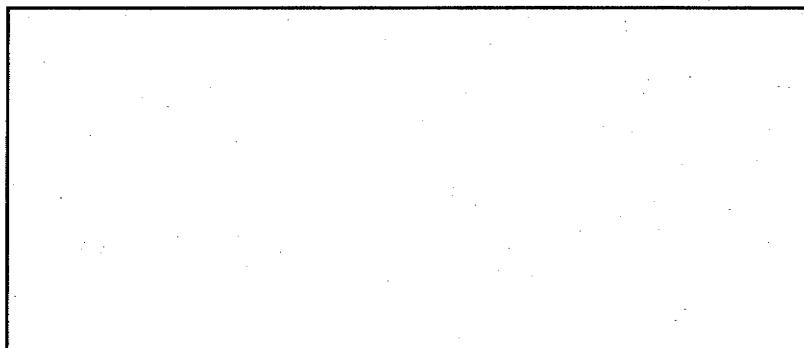


Hint: The IR spectrum of A shows a strong signal at 3500 cm^{-1} , but there is no signal above 3200 cm^{-1} for B or C.

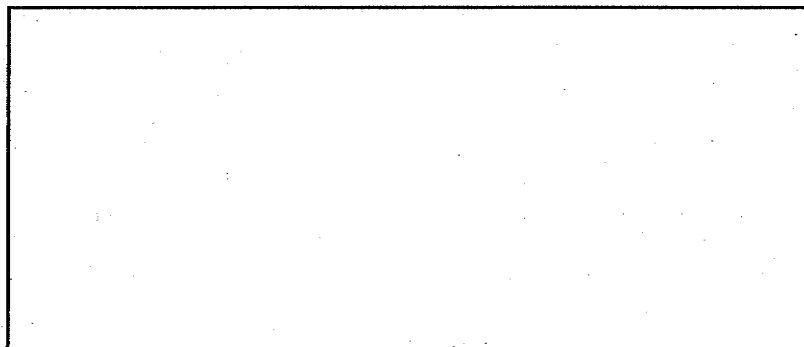
A =



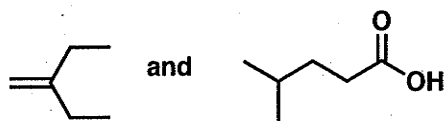
B =



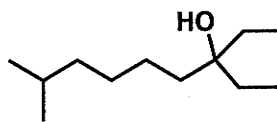
C =



5. (24 points) Devise a synthetic beginning with the "starting materials" to generate the "target", using any necessary reagents.



Starting Materials



Target

<u>Problem #</u>	<u>Score</u>
1	/ 20
2	/ 18
3	/ 20
4	/ 18
5	/ 24
Total:	/ 100

TABLE 14.3 Typical Infrared Absorptions of Functional Groups^a

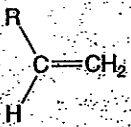
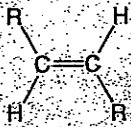
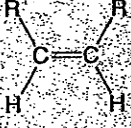
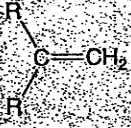
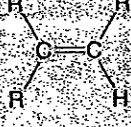
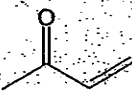
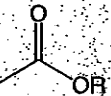
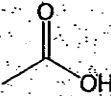
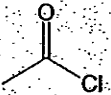
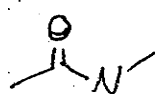
Functional Group	Position (cm ⁻¹)	Intensity ^b
Alkanes		
C-H	2980-2850	m-s (stretch)
C-C	1480-1420	m (bend)
Alkenes		
=C-H	3150-3000	m (stretch)
C=C	1680-1620	m-w (stretch)
(conj) C=C	1630-1600	m-w (stretch)
	995-985 915-905	s (out-of-plane bend)
	980-960	s (out-of-plane bend)
	730-665	s (out-of-plane bend) (br, variable)
	895-885	s (out-of-plane bend)
	840-790	m (out-of-plane bend)
Alkynes		
≡C-H	3350-3300	s (stretch)
C≡C	2260-2100	m-w (stretch)
Alcohols		
O-H		
free	3650-3580	m (stretch)
hydrogen bonded	3550-3300	br, s (stretch)
C-O	1350-1250 1150-1050	s (stretch)
Amines		
N-H	3500-3100 (two bands for primary amines one band for secondary amines)	br, m (stretch)

TABLE 14.3 (CONTINUED)

Functional Group	Position (cm ⁻¹)	Intensity ^b
C-N	~1200	m (stretch)
Aromatic compounds		
=C-H	3080-3020	m-w (stretch)
C=C	1650-1580	m-w (stretch)
C-H		
mono	770-730	s (out of plane bend)
	710-690	
ortho	770-735	s (out-of-plane bend)
meta	900-860	m (out of plane bend)
	810-750	s (out-of-plane bend)
	725-680	m (out-of-plane bend)
para	860-800	s (out-of-plane bend)
Carbonyl compounds		
aldehydes, ketones		
		
C=O	1730-1700 (higher in strained cyclic molecules)	s (stretch)
		
	1680-1660	s (stretch)
C-H (aldehydes)	2900-2700 (two bands)	w (stretch)
Esters		
	1750-1735 1300-1000	s (C=O) (stretch) s (C-O) (stretch)
Acids		
	1730-1700 3200-2800	s (C=O) (stretch) s, br (O-H) (stretch)
Acid chlorides		
	1820-1770	s (C=O) (stretch)

Amides



1620-1680 s (C=O) (stretch)

PERIODIC TABLE OF THE ELEMENTS

1

18
VIII

Atomic number →
Symbol →
Name (IUPAC) →
Atomic mass →

IUPAC recommendations →
Chemical Abstracts Service group notation →

1 H Hydrogen 1.008	2 He Helium 4.0026	3 Li Lithium 6.941	4 Be Beryllium 9.0122	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	11 Na Sodium 22.990	12 Mg Magnesium 24.305	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.409	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	72 Hf Hafnium 178.49
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)
101 Db Dubnium (262)	102 Sg Seaborgium (266)	103 Bh Bohrium (264)	104 Hs Hassium (277)	105 Mt Meitnerium (268)	106 Ds Darmstadtium (271)	107 Uu Ununseptium (281)	108 Uub Unbibium (285)	109 Uut Untrium (289)	110 Uuq Unquadrium (293)	111 Uuh Unhexium (297)	112 Uub Unbibium (295)	113 Uut Untrium (297)	114 Uuq Unquadrium (289)	115 Uup Unpentium (291)	116 Uuh Unhexium (295)	117 Uus Unseptium (293)	118 Uuo Unoctium (294)

*Lanthanide Series

Actinide Series

