Hour Exam #3
Chemistry 345
Professor Gellman
1 May 2015

Last Name _____

First Name _____

General Instructions:

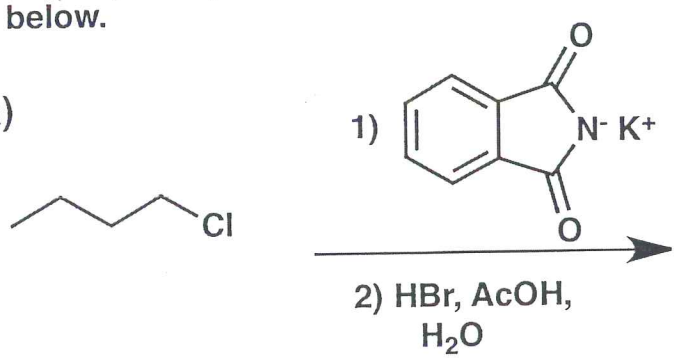
(i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit. Models are allowed.

(ii) Print your name on each page.

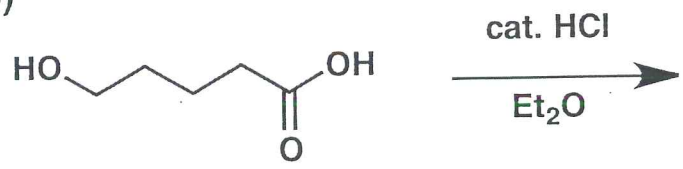
(iii) Please keep your paper covered and your eyes on your own work. No electronic devices may be used. Misconduct will lead to failure in the course.

1. (19 points) Show the ORGANIC product(s) expected from the reactions indicated below.

(a)

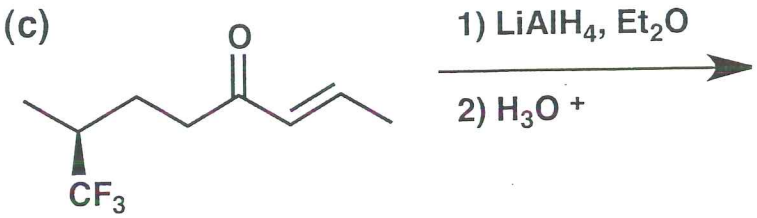


(b)



[HINT: The organic product has a strong IR signal at 1740 cm^{-1}, and no IR signal above 3000 cm^{-1}.]

(c)

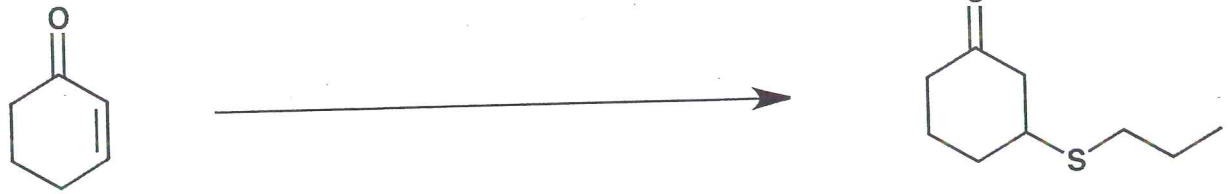


[single enantiomer]

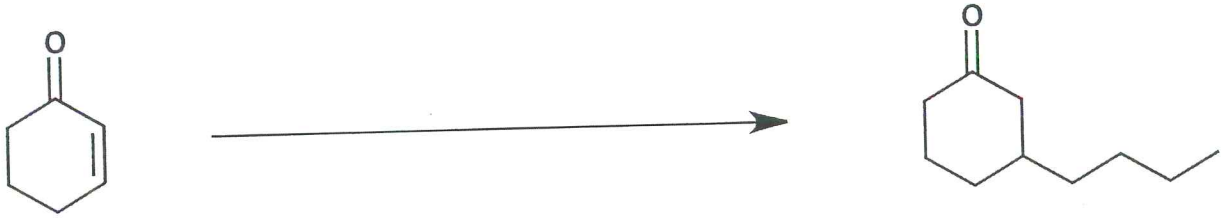
Name _____

2. (29 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 or under the arrow.

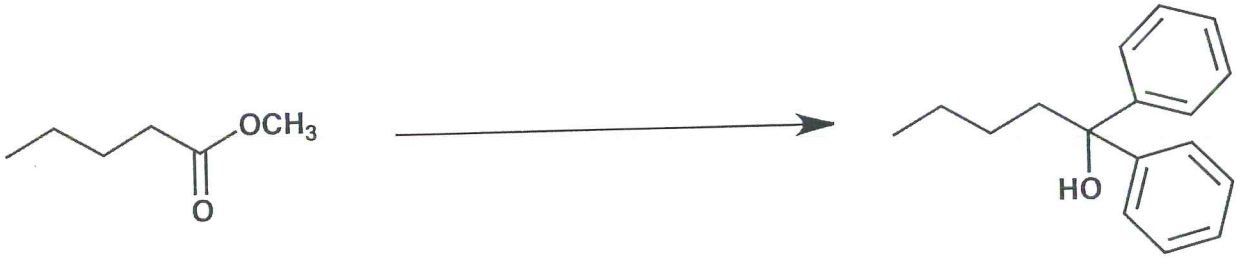
(a)



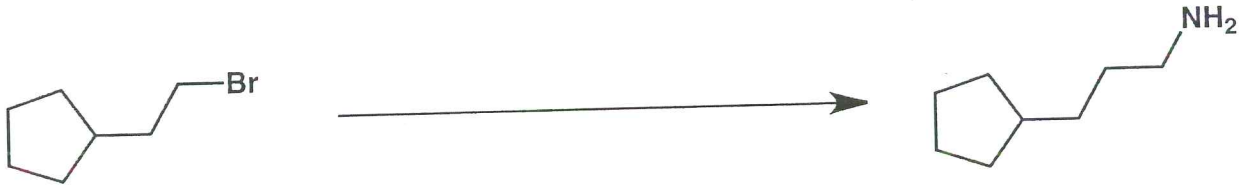
(b)



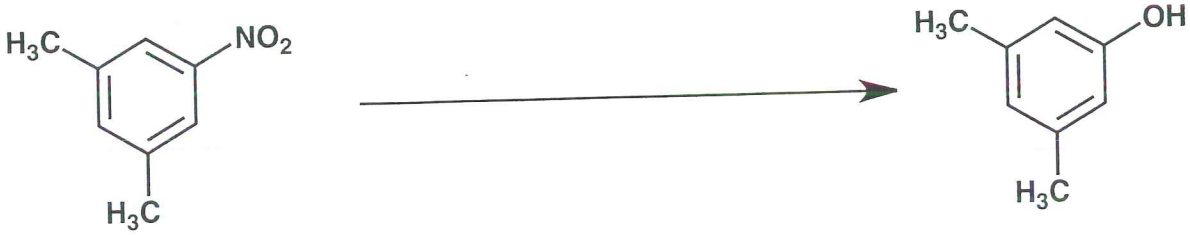
(c)



(d)



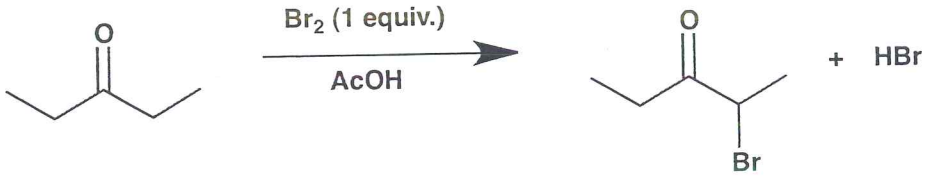
(e)



Name _____

3. (24 points) Provide a mechanism (curved arrows) for each reaction shown below. Draw all important resonance structures for intermediates.

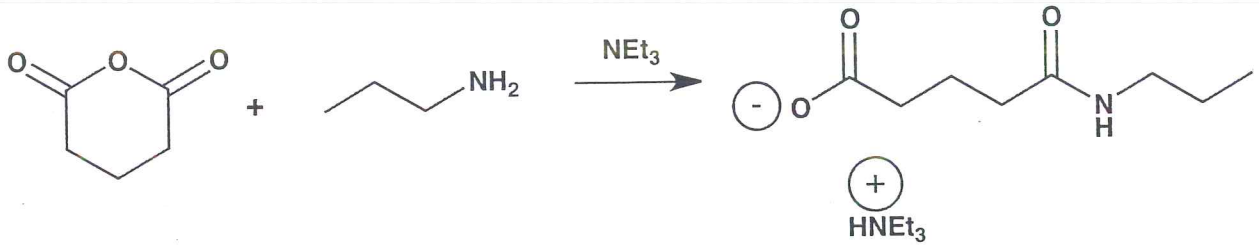
(a)



(cont. on next page)

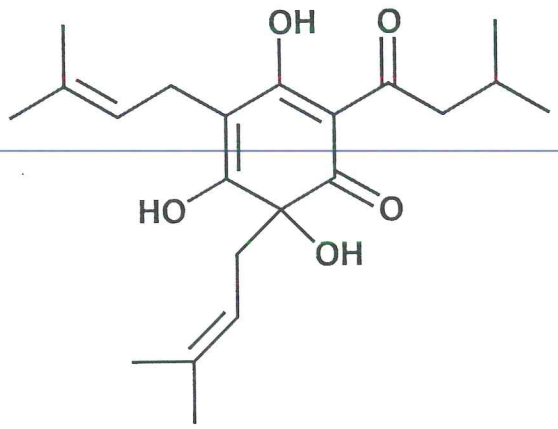
Name _____

3. (cont.)

(b) 

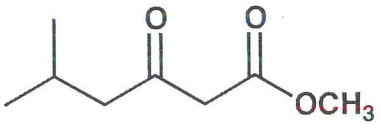
Name _____

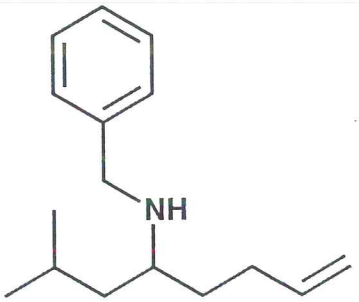
4. (10 points) The molecule shown below, humulone, contributes to the bitter taste of many beers. This molecule is released by the hops during the brewing process. This molecule is relatively acidic. Show the conjugate base that would be formed by removing the most acidic proton; draw all resonance structures of this basic form.



Name _____

5. (18 points) Propose an efficient synthetic route from the indicated starting material to the target. You may use any other starting materials and reagents.

Starting material = 

Target = 

Name _____

Problem #	Score
1	/ 19
2	/ 29
3	/ 24
4	/ 10
5	/ 18

_____

Total: / 100

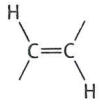
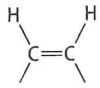
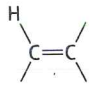
Periodic Table of the Elements

																	2 He 4.003
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.011	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac (227)	104 Unq* (261)	105 Unp* (262)	106 Unh* (263)	107 Uns* (262)	108 Uno* (265)	109 Una* (266)									

Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinides	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (249)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

*Symbol (and name) provisional.

Numbers in parentheses: available radioactive isotope of longest half-life.

Type of absorption	Frequency, cm^{-1} (Intensity)*	Comment
	Alkanes	
C—H stretch	2850–3000 (m)	occurs in all compounds with aliphatic C—H bonds
	Alkenes	
C═C stretch		
—CH═CH_2	1640 (m)	
	1655 (m)	
others	1660–1675 (w)	not observed if alkene is symmetrical
═C—H stretch	3000–3100 (m)	
═C—H bend		
—CH═CH_2	910–990 (s)	
	890 (s)	
	960–980 (s)	
	675–730 (s)	position is highly variable
	800–840 (s)	
	Alcohols and Phenols	
O—H stretch	3200–3400 (s)	
C—O stretch	1050–1250 (s)	also present in other compounds with C—O bonds: ethers, esters, etc.
	Alkynes	
C≡C stretch	2100–2200 (m)	not present or weak in many internal alkynes
≡C—H stretch	3300 (s)	present in 1-alkynes only
	Aromatic Compounds	
C═C stretch	1500, 1600 (s)	two absorptions
C—H bend	650–750 (s)	
overtone	1660–2000 (w)	

*(s) = strong; (m) = medium; (w) = weak.

(Table continues)

Type of absorption	Frequency, cm^{-1} (Intensity)*	Comment
	Aldehydes	
C=O stretch		
ordinary	1720–1725 (s)	
α,β-unsaturated	1680–1690 (s)	
benzaldehydes	1700 (s)	
C—H stretch	2720 (m)	
	Ketones	
C=O stretch		
ordinary	1710–1715 (s)	increases with decreasing ring size (Table 21.3, p. 996)
α,β-unsaturated	1670–1680 (s)	
aryl ketones	1680–1690 (s)	
	Carboxylic Acids	
C=O stretch		
ordinary	1710 (s)	
benzoic acids	1680–1690 (s)	
O—H stretch	2400–3000 (s)	very broad
	Esters and Lactones	
C=O stretch	1735–1745 (s)	increases with decreasing ring size (Table 21.3, p. 996)
	Acid Chlorides	
C=O stretch	1800 (s)	a second weaker band sometimes observed at 1700–1750
	Anhydrides	
C=O stretch	1760, 1820 (s)	two bands; increases with decreasing ring size in cyclic anhydrides
	Amides and Lactams	
C=O stretch	1650–1655 (s)	increases with decreasing ring size (Table 21.3, p. 996)
N—H bend	1640 (s)	
N—H stretch	3200–3400 (m)	doublet absorption observed for some primary amides
	Nitriles	
C≡N stretch	2200–2250 (m)	
	Amines	
N—H stretch	3200–3375 (m)	several absorptions sometimes observed, especially for primary amines

*(s) = strong; (m) = medium; (w) = weak.