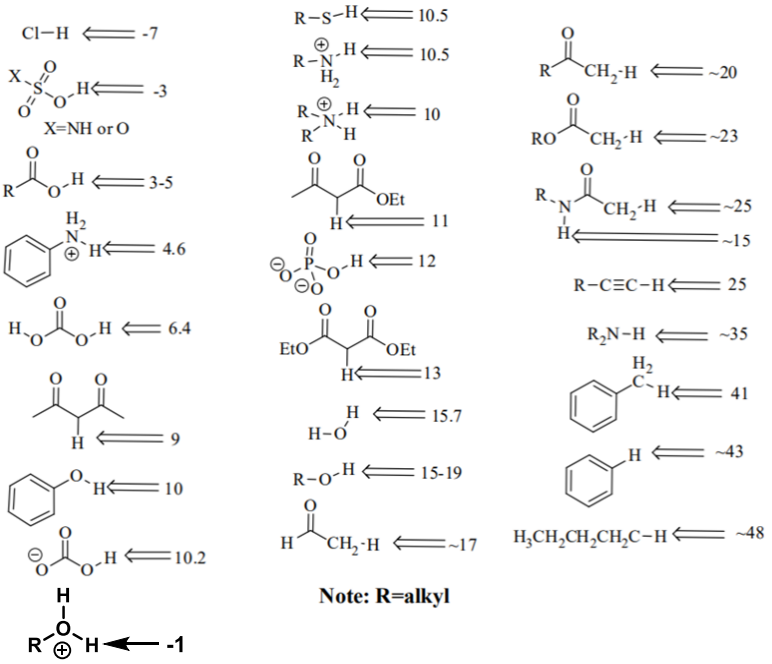
Name: _____

IA																	0
1 H 1.008	IIA											IIIA	IVA	VA	VIA	VIIA	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	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 58.70	29 Cu 63.55	30 Zn 65.38	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)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 * La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226.0)	89 ** Ac (227)	104 Rf	105 Ha	106 Unh	107 Uns	108	109 Une									

* 58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
** 90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (244)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

pK_a information



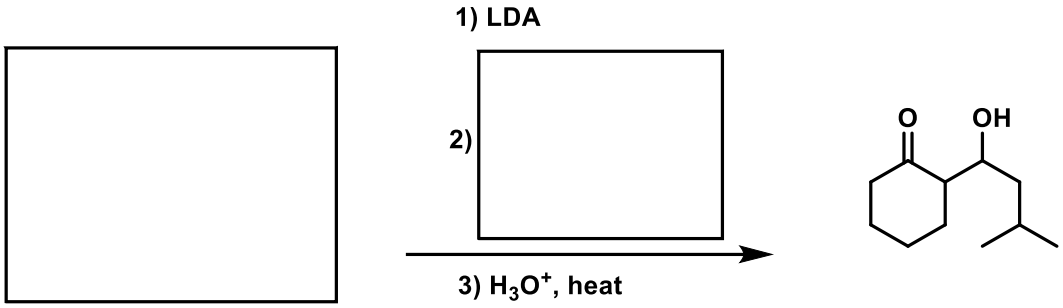
Note: R=alkyl

Bonus. (+1 pt) Initial here _____ to certify that you understand that *none* of the reactions on this exam are stereospecific, and if a new chiral center is generated, it may have either configuration (which we would normally denote with a * at that chiral center).

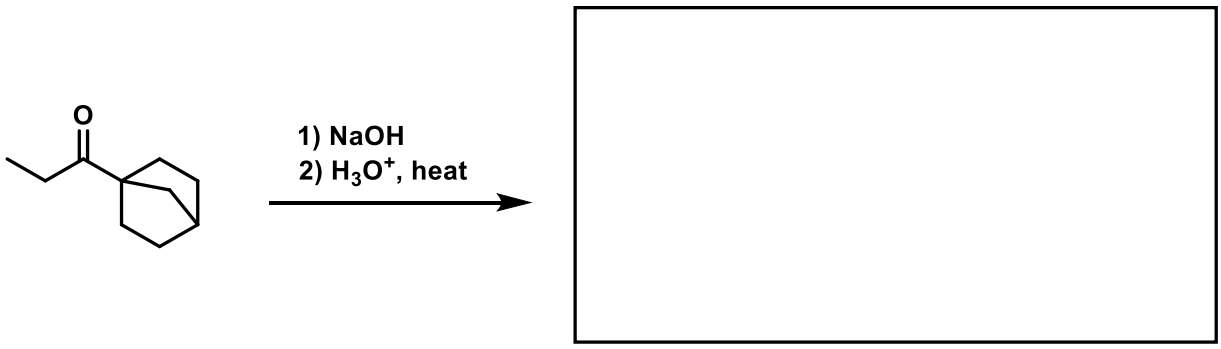
You do **not need to label ***any*** newly generated chiral centers on this exam.**

1. Fill in the missing reactant, reagent(s), or major organic product in each box below.

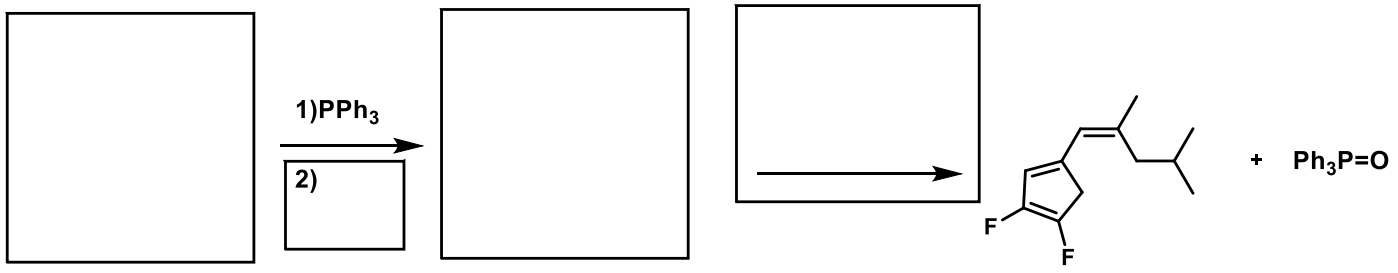
a.) (5 pts)



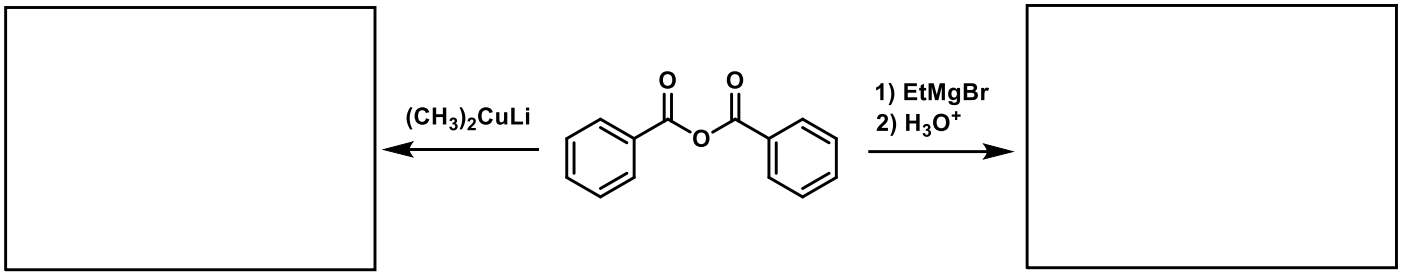
b.) (3 pts)



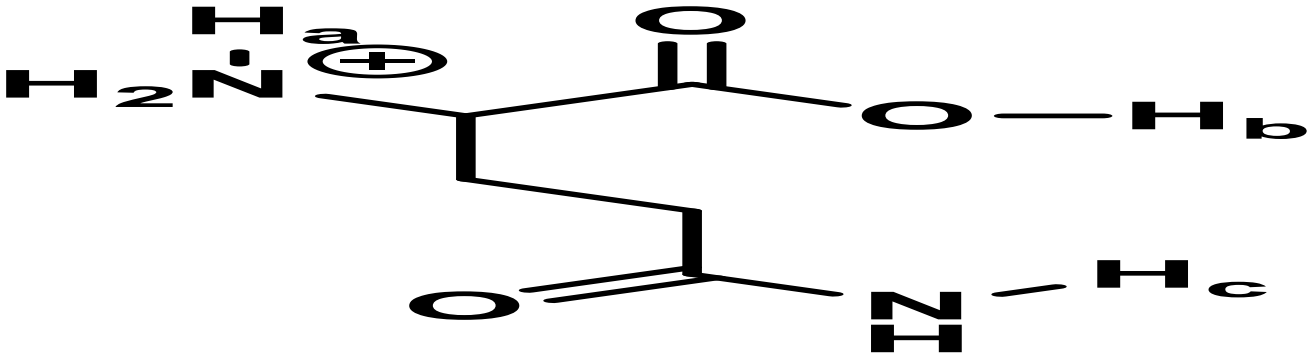
c.) (7 pts)



d.) (4 pts)

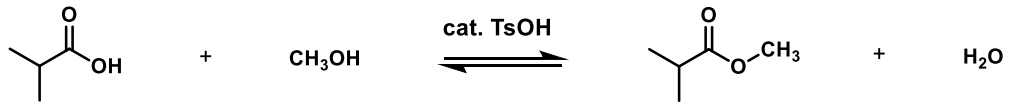


e.) (7 pts)



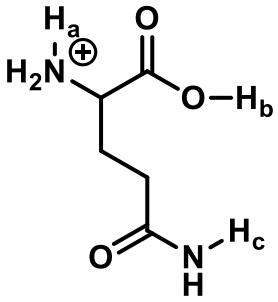
f.) (6 pts)

2. a.) Provide an arrow pushing mechanism for the reaction shown below. You may use general acid-base notation. If you require an acid, use H-A. If you require a base, use $:A^-$. (8 pts)



b.) The reaction above is highly reversible. What conditions would you use in order to favor the reactants at equilibrium? (2 pts)

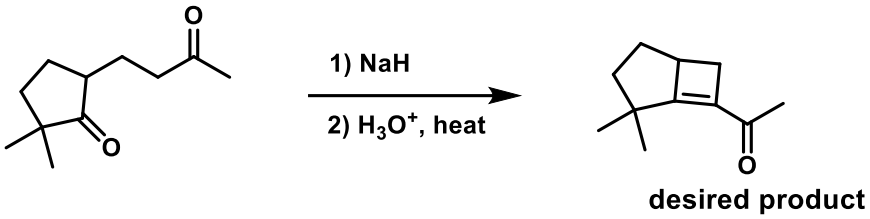
3. (7 pts total)
a.) The structure of the amino acid glutamine is shown below. Rank the three labeled protons in order of least to most acidic.



Least acidic Most Acidic

b.) **<u>Circle</u>** the proton(s) that would be **irreversibly** removed by treatment with excess NaOH. Briefly explain your reasoning for full credit.

4. A graduate student is trying to synthesize the ring below via an intramolecular Aldol reaction. Their mass spectrum indicates the correct molecular formula and a highly pure product, but the splitting and integrations of several NMR peaks don't match up with the desired product. Draw the structure of the observed product they actually made, and explain why they won't get their desired product through this route. ***Do NOT*** *propose a new synthetic route to the desired product*! (6 pts)



desired product

explanation

observed product

Name: _____

IA												IIIA	IVA	VA	VIA	VIIA	0
1 H 1.008	IIA																2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	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 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
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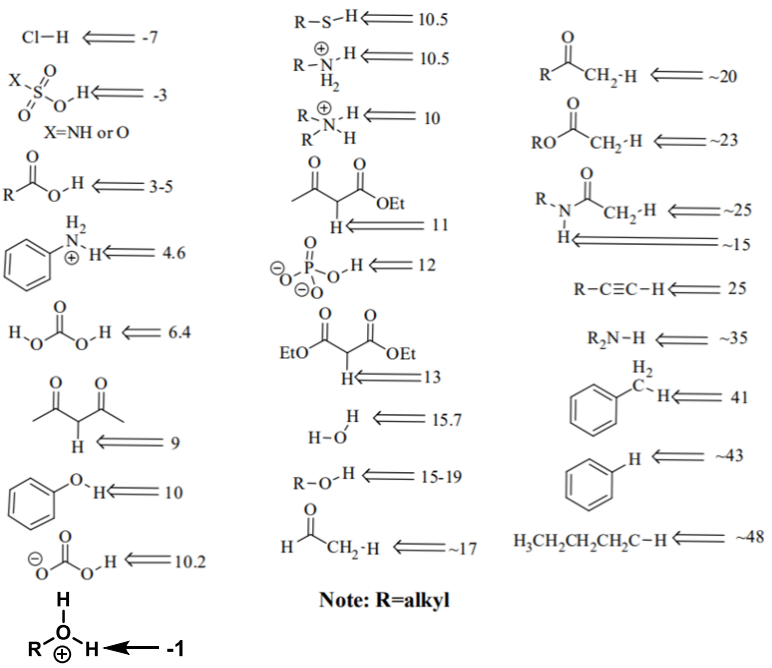
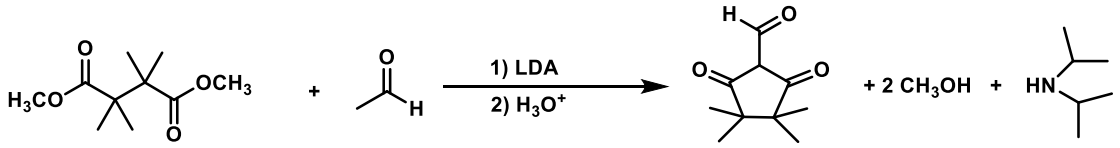
pK_a information

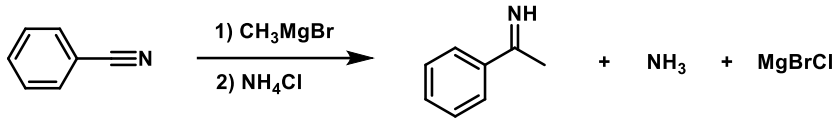


Note: R=alkyl

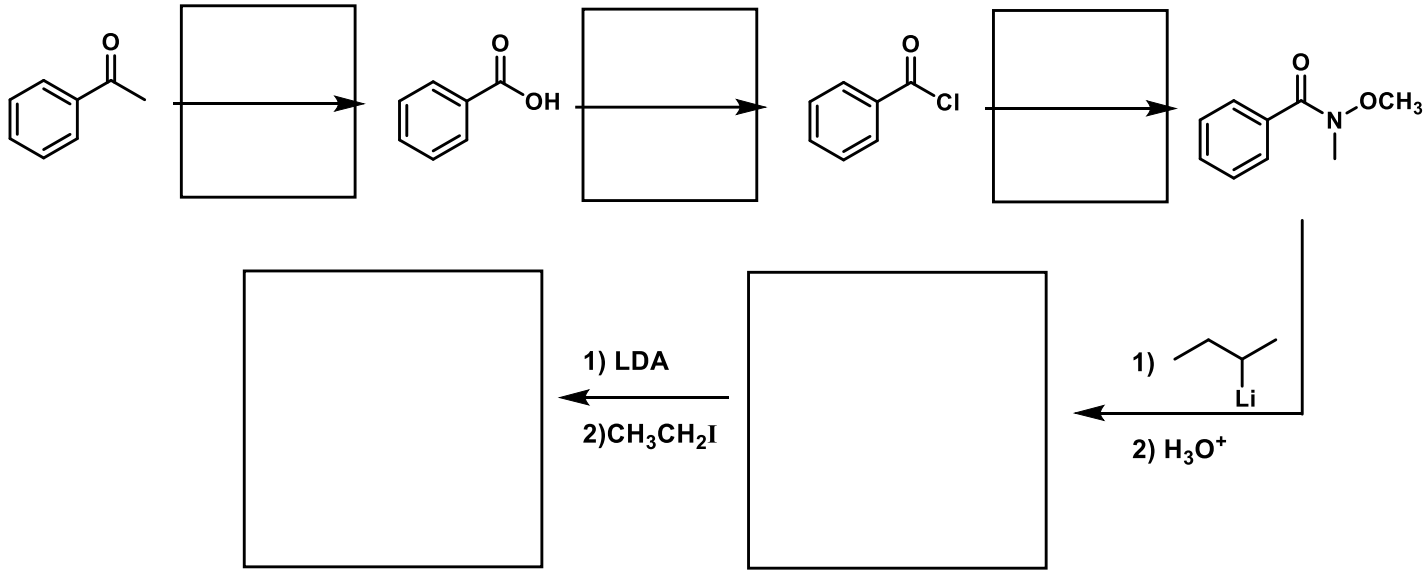
5. Provide an arrow pushing mechanism for the reaction shown below. (12 pts)



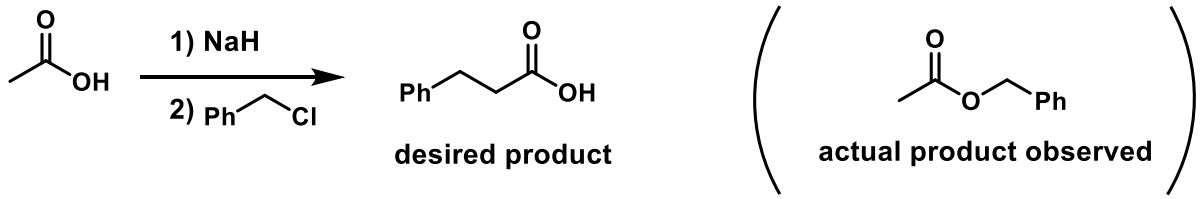
6. Nitriles (R-C≡N:) react analogously to carbonyls in many ways. When a nitrile reacts with a Grignard followed by treatment with a weak, nonaqueous acid, an imine is formed. Propose a stepwise mechanism for the reaction shown below. (5 pts)



7. Fill in the missing reagents or intermediates to complete the synthetic scheme below (10 pts)

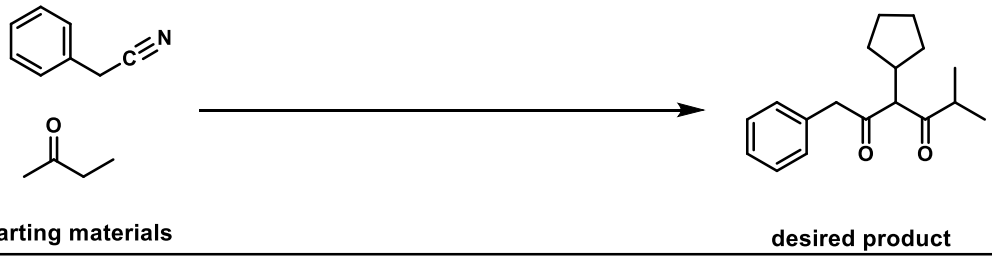


8. (8 pts total) The reaction below does not yield the **desired product**. Instead, an ester is formed.
   a. Provide a stepwise mechanism for the formation of the **actual product observed** (the ester).



   b. Propose a revised synthesis that will yield the desired product. **<u>You must use the same alkyl halide shown in step 2) above</u>**, but you can start with a different carbonyl compound.

9. (10 pts) The **desired product** below can be made from the given **starting materials** using reactions we have learned in class. You must use both of the starting materials. Provide a synthesis in the box below. *Hint:* you'll have to alter both of the starting materials before they react with each other.



starting materials **desired product**