CHEM 234, Spring 2013	the exam cov	ver shee	ets loo	ok k	ind o	of like tl	nis	lan R	. Gould
PRINTED PRIN FIRST NAME LAST		D ME				ASU Postir	ID or ng ID		
Person on your <b>LEFT</b> (or	r Aisle)			F	Persor	n on your l	<b>RIGHT</b> (c	or <b>Aisle</b> )	
• PRINT YOUR NAME ON EACH	PAGE!				0.10				
• READ THE DIRECTIONS CAREFULLY!		THIS IS A CHM 234							
$\cdot$ USE BLANK PAGES AS SCRATCH PAPER		PRACTICE EXAM							
work on blank pages will not b	e graded				_				
•WRITE CLEARLY!		MIDTERM #1							
MOLECULAR MODELS ARE AL	LOWED	P	<b>PRA</b>		TIC	CE T	EST	'#1	
DO NOT USE RED INK	SENCEL								
· DON I CHEAI, USE COMMONS	ENSE	Extra Crec	dit	/5		Total (ind	el Extra)	/1	75+5
Н					He	Intera	ction E	nergies, kc	al/mol
Li Be		ВС	N O	F	Ne	Ecli	psing	Gaucl	ne
Na Mg		Al Si	PS	cl	Ar	н/н	~1.0	Me/Me	~0.9
K Ca Sc Ti V Cr Mn H	'e Co Ni Cu Zn	Ga Ge	As Se	Br -	Kr	H/Me Me/Me	~1.4	Et/Me i-Pr/Me	~0.95
RD Sr Y Zr ND MO TC F	Ru Rh Pa Ag Ca	In Sn	SD TE	1	xe Bn	Me/Et	~2.9	t-Bu/Me	~2.7
		Infrare	ed Corre	lation	Chart	JL		Approximate Co	upling
→ small range → · · · · · · · · · · · · · · · · · ·	C=O			~	~			Constants, J (H <sup>1</sup> H NMR Spel	z), for ctra
broad peak /	/* *			<b>ц</b> ′	й С 1	600–1660 M	)   	ц ц	
≡с-н Ус′	Ăн					0 II		-ç-ç-	~7
3300 — U, H	2720–2820	—c≡n			<u> </u>	_0 			
<u>зооо-</u> <sup>2 реакs</sup> N-н <sup>3100</sup> 2 реакs 2 реак 2 р					, н С=С ~10 л	~ <sup>H</sup>			
broad with spikes ~3300	с—н			•	₽ 1735	় ক	⁄ ال	н	н∽
—0-H	50–2960	—с≡сн √			0	1600		c₌c(_~2	н,∕∕
$\begin{array}{c c} \hline & & \\ \hline \\ \hline$				~2 🦊					
broad ~300	0		0000		1710	1650	NR <sub>2</sub>	C₌C´~ <sup>15</sup> H	Н
(cm <sup>-1</sup> )         3500         3000         2500         2000         1500         11           amine         B=NHe         variable and condition         NMR correlation Charte         OCH         O									
alcohol R-OH dependent, ca. 2 - 6 $\delta$									
$O \qquad \qquad \text{Aromatic Ar} = H \qquad \qquad \text{H}_{aC} - NB_{a}$									
$\begin{array}{ccc} O & & & & & \\ O & & & & & \\ B & C & OH \end{array} \qquad $									
$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 9 & 8 & 7 & 6 & 5 & 4 & 3 & 2 & 1 & 0 \\ 1 & 1 & 1 & 0 & 9 & 8 & 7 & 6 & 5 & 4 & 3 & 2 & 1 & 0 \end{bmatrix}$									
(0, pp(1))         220         200         180         160         140         120         100         80         60         40         20         0           B         C≡N         -OCH2-									
	о с—	R₂C=0		-1"				$\frac{1}{2} \text{ Alkyl } \frac{3^{Y} > 2}{2}$	$2^{\gamma} > 1^{\gamma}$
		matia			Ļ			/- <u>/</u>	
		malic	-			⊢			

CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1 <sup>-2-</sup> NAME Question 1 (10 pts.) Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.



Question 2 (16 pts). Rank in order of INCREASING Bronsted acidity the hydrogens Ha, Hb, Hc and Hd. Give a BRIEF explanation that includes the term "energy of electrons" and also include a discussion of base strength. Draw the conjugate base anion corresponding to deprotonation of  $H_a$  (ONLY) to help in your explanation.

 <	 <	 <	



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1 - 3 -NAME

Question 3 For each reaction

- Provide the missing reagents/conditions or major organicproducts as appropriate
   State whether the OVERALL reaction is Addition, Elimination, Substitution or Rearrangement
   State whether the OVERALL is Reduction, Oxidation or Neither unless otherwise specified
   Pay attention to stereochemistry including racemic mixtures unless specified



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1 -4-

NAME

Question 6. Show how you would synthesize the target compond on the right from the starting compound on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

CN

Question 5 For EACH of the two indicated bonds A and B, perform retrosynthetic analysis and draw the best synthons. Only one of these bond can actually be made, indicate which one, and for this reaction ONLY give the actual reactants/synthetic equivalents you would use to make that bond, give the curved arrow pushing showing bond formation and BRIEFLY explain why the other bond can not be made







#### CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1

NAME

Question 13. For BOTH reactions A and B

a) Give the products AND THE mechanisms for ELIMINATION of HCl for the provided reagents/conditions, indicate the Lewis and Bronsted acids/bases at each BIMOLECULAR step as appropriate

b) For each mechanism, give the number of sets of intermediates and transition states for each

- 9 -

→ CH<sub>3</sub>OH heat Α

number of sets of intermediates \_\_\_\_\_\_ number of transition states \_\_\_\_\_\_

B /

number of sets of intermediates \_\_\_\_\_\_ number of transition states \_\_\_\_\_

c) Draw a reaction energy diagram ON THE SAME DIAGRAM for each mechanism, clearly indicate which reaction refers to which diagram, indicate the rate determining steps for each reaction (you do not need to indicate or draw transition states)



d) Which reaction, A or B, would be faster? Give a BRIEF explanation.

CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1 - 6 -

Question 8 (35 pts). For **EACH**, give a complete curved arrow pushing mechanism, and... 1) Show **ALL important resonance contributors for all intermediates.** 2) Add non-bonding electrons and C-H bonds to the line-angle structures as required. 3) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB) 4) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM

NAME







CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #1<sup>-6-</sup> NAME

Question 6) For (2R,3S)-dibromobutane (meso-1,2-dibromobutane) a) Draw a 3-D structure using wedged/dashed bonds showing the stereochemistry at the two asymmetric centers, IN THE REACTIVE CONFORMATION FOR AN E2 ELIMINATION

b) Draw a Newman projection for the reactive conformation for E2 elimination, **looking FROM** carbon #2 TO carbon #3.

c) Give the product of E2 elimination to give the Sayetzeff (Zaitsev) alkene product

Question 12) For each of the following reactions, give the major organic product and assign the mechanism as E1, E2, SN1 or SN2 and briefly explain the reasoning for your choice. Indetify all stereoisomeric products as appropriate.

Na+-OH a) DMF



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #2

NAME

- 2 -

# **START OF PRACTICE TEST #2**

Question 1 (10 pts.) Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.



Question 2 (16 pts). For the indicated bond in the provided structure:

a) Perform retrosynthetic analysis to generate the best synthons and give a BRIEF

JUSTIFICATION FOR YOUR CHOICE OF POSITIVE AND NEGATIVE SYNTHON

b) Provide the synthetic equivalents that can be used to make the bond in an SN2 reactionc) You can sue any reasonable leaving group, if a counter ion is required then use any alkali metal, you do not have to specify the solvent.

d) Add the curved arrow-pushing to the reactants in the SN2 reaction and indicate the Lewis acid and base AND nucleophile and electrophile.





CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #2 - 3 -NAME Question 3 For each reaction

Provide the missing reagents/conditions or major organicproducts as appropriate
 State whether the OVERALL reaction is Addition, Elimination, Substitution or Rearrangement
 State whether the OVERALL is Reduction, Oxidation or Neither unless otherwise specified
 Pay attention to stereochemistry including racemic mixtures unless specified



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #2 - 4 -

NAME

### Question 4

Rank in order of INCREASING Bronsted acidity. Give a BRIEF explanation for your choice that must be illustrated by including drawings of ALL of the important resonance contributors for the conjugate base anion obtained upon deprotonation of structure A (ONLY). You explanation shoull also mention Bronsted base strength.



Question 5 Sodium borohydride (NaBH<sub>4</sub>) reduces only aldehydes and ketones. Lithium aluminum hydride (LiAlH<sub>4</sub>) will reduce aldehydes and ketones and also esters and carboxlic acids. Give a BRIEF explanation for the different reactivities of NaBH<sub>4</sub> and LiAlH<sub>4</sub>. Include the term "Lewis base" in your explanation.

CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #2 -5- NAME

Question 6. Show how you would synthesize the target componds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

a) MeO b) Br Br-

CHEMISTRY 234, MIDTERM #1 **PRACTICE TEST #2**<sup>-6-</sup> NAME Question 7 For **EACH**, give a complete curved arrow pushing mechanism, and... 1) Show **ALL important resonance contributors for all intermediates.** 2) Add non-bonding electrons and C-H bonds to the line-angle structures as required. 3) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB) 4) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM





CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #3

NAME

\_

# **START OF PRACTICE TEST #3**

Question 1 Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

- 2 -



Question 2. For the following Bronsted acid/base equilibrium

a) Indicate the stronger and weaker acid and base on each side

b) Indicate which reaction is faster and which reaction slower and clearly which side the equilibrium will lie

c) Indicate which acid has the larger and which the smaller pKa

d) Give a brief explanation for your choice of stronger/weaker acid, mention Bronsted base strength

$$F_3C-CH_2$$
;  $\stackrel{\otimes}{:}$  + ;  $\stackrel{\circ}{:}$   $CH_2-CCI_3$   $\stackrel{\bullet}{=}$   $F_3C-CH_2$ ; +  $\stackrel{\otimes}{:}$   $\stackrel{\circ}{:}$   $CH_2-CCI_3$   
H

Question 3. Anion B is a stronger Bronsted base than anion A. Give an explanation that includes the terms "inductive effect" and "resonance", and whether the  $H_2N$ - substituent is overall electron donating or with drawing. You do not need to draw additional resonance contributors.



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #3 - 3 -NAME

Question 4 For each reaction

- Provide the missing reagents/conditions or major organicproducts as appropriate
   State whether the OVERALL reaction is Addition, Elimination, Substitution or Rearrangement
   State whether the OVERALL is Reduction, Oxidation or Neither unless otherwise specified
   Pay attention to stereochemistry including racemic mixtures unless specified



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #3 - 4 -

NAME

Question 5. Show how you would synthesize the target componds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #3 -5-

reaction:

NAME Question 6. In the provided structure, one of the bonds is most obviously made in an SN2

a) Indicate the bond on the structure and perform retrosynthetic analysis to generate the best synthons and give a BRIEF JUSTIFICATION FOR YOUR CHOICE OF POSITIVE AND NEGATIVE SYNTHON

b) Provide the synthetic equivalents that can be used to make the bond in an SN2 reaction

c) You can use any reasonable leaving group, if a counter ion is required then use any alkali metal, you do not have to specify the solvent.

d) Add the curved arrow-pushing to the reactants in the SN2 reaction and indicate the Lewis acid and base AND nucleophile and electrophile.



Question 7. Rank the following three reactions in order on INCREASING exothermicity and give a brief explanation.  $H_2$ 



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #3 - 6 -NAME

Question 8 For **EACH**, give a complete curved arrow pushing mechanism, and... 1) Show **ALL important resonance contributors for all intermediates**. 2) Add non-bonding electrons and C-H bonds to the line-angle structures as required. 3) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB) 4) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #4

NAME

# **START OF PRACTICE TEST #4**

Question 1 Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

- 2 -



Question 2 Rank the following hydrogens Ha, Hb and Hc in order of increasing Bronsted acidity. Draw the conjugate base anions for each including ALL relevant resonance contributors. Give a brief explanation that includes a discussion of base strength.







CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #4 - 3 - NAME

Question 3. For each reaction.

Provide the missing reagents/conditions or major organicproducts as appropriate
 Pay attention to stereochemistry including racemic mixtures unless specified



NAME

Question 9 For (1S,2S)-1-bromo-1,2-diphenylpropane, draw

a) a 3D structure showing sterochemistry in terms of wedged and dashed bonds
b) a Newman projection of BOTH the lowest energy conformer for rotation around the C1-C2 bond, AND a Newman projection of the conformer that would undergo an E2 elimination
c) the alkene product of an E2 elimination

	[]	[]	
	lowest		
3D structuro		EQ conformer	alkana product
	energy contonner	E2 conionner	aikerie product

Question 5. In the provided structure, one of the bonds can made in an SN2 reaction: a) Indicate the bond on the structure and perform retrosynthetic analysis to generate the best synthons and give a BRIEF JUSTIFICATION FOR YOUR CHOICE OF POSITIVE AND NEGATIVE SYNTHON

b) Provide the synthetic equivalents that can be used to make the bond in an SN2 reaction c) You can use any reasonable leaving group, if a counter ion is required then use any alkali metal, you do not have to specify the solvent.

d) Add the curved arrow-pushing to the reactants in the SN2 reaction and indicate the Lewis acid and base AND nucleophile and electrophile.



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #4 - 5 -

NAME

Question 5. Show how you would synthesize the target componds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.



Give the reactants to synthesize the provided structures in an SN2 reaction. One of the bonds in each structure is the obvious one to make in an SN2 reaction, in these problems you will have to decide which it is



CHEMISTRY 234, MIDTERM #1 PRACTICE TEST #4<sup>-6-</sup> NAME

Question 6. For **EACH**, give a complete curved arrow pushing mechanism, and... 1) Show **ALL important resonance contributors for all intermediates**. 2) Add non-bonding electrons and C-H bonds to the line-angle structures as required. 3) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB) 4) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM



