

CHM 2120
SAMPLE Midterm #1
September, 2013

First Name: _____ Last Name: _____

Student Number: _____ Seat number: _____

Approximate total number of marks: 82

The marks are given as a guide and are subject to change.

You can write in pen or in pencil.

The use of molecular models is permitted but they cannot be shared.

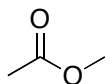
The use of calculators or other electronic devices is not permitted.

1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0		
1 H															2 He		
3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne	
11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106												

1. Draw the structure of (2*S*,3*R*,*Z*)-2-aminonon-7-en-3-ol. **(3 points)**

2.

- Draw all of the resonance structures of the following compound using arrows to show the movement of electrons. **(4 points)**
- Draw the resonance hybrid structure. **(2 points)**

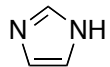


3.

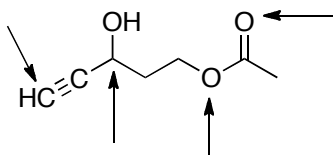
- Draw the mechanism and products for the following reaction. **(5 points)**
- Will the reaction favour the starting materials or the products? **(1 point)**
- Justify your choice in part b. **(3 points)**



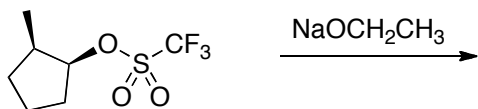
4. Circle the most basic nitrogen atom in the following compound and justify your choice. Draw structures to support your answer. (3 points)



5. Identify the hybridization state for each of the atoms indicated with an arrow. (4 points)

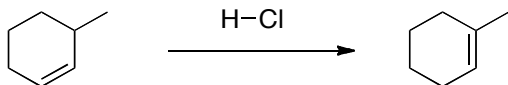


6. For the following reaction:
- Draw the mechanism to show the formation of the **major** organic elimination product: (4 points)



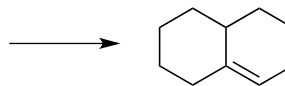
- Draw the minor organic product. (4 points)

7. Draw a mechanism to explain the formation of the product shown. (4 points)

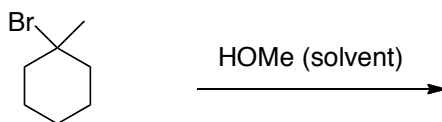


8. Draw the starting material(s) **OR** the major organic product(s) for each of the following reactions: (3 points each, total = 6 pts)

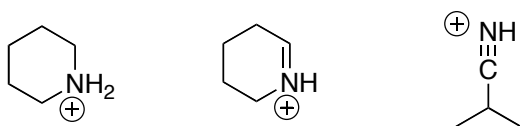
a.



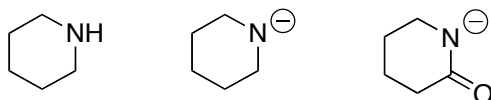
b.



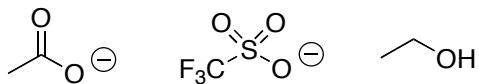
9. Circle the strongest acid in the following set: (1 point)



10. Circle the strongest base in the following set: (1 point)



11. Circle the best leaving group in the following set: **(1 point)**

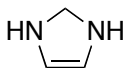


12. Decide whether each of the following compounds is aromatic, anti-aromatic, or non-aromatic. **(3 points)**

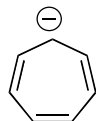
a.



b.

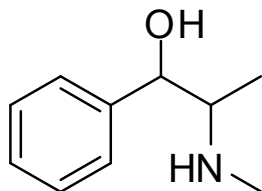


c.



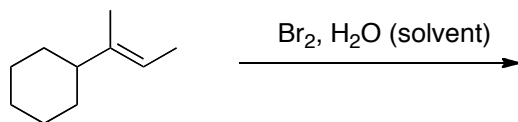
13. Ephedrine has the structure shown below but with the (1*R*, 2*S*) configuration.

- Draw its structure with the correct configurations at the stereocentres. The priorities given to each group to determine the correct structure must be indicated (redrawing the structure for each chiral centre helps). **(4 points)**
- Draw a diastereomer of ephedrine. **(2 points)**

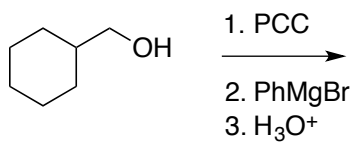


14. Provide a mechanism and the major organic product of each of the following reactions. (6 points each = 18 points)

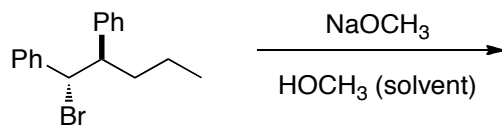
a.



b.

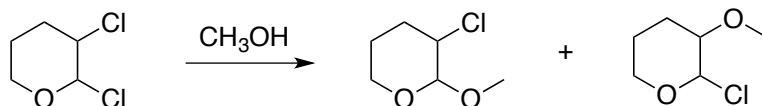


c. Please include a Newman projection of the reactive conformation.



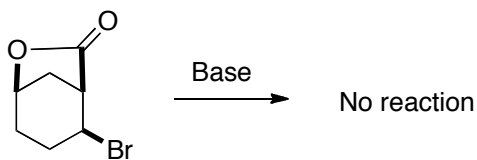
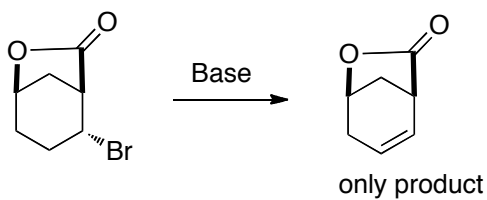
15.

- Draw a mechanism showing the formation of the each product of the following reaction. **(6 points)**
- Circle the major product. **(1 point)**
- Justify your answer in part b. **(2 points)**



Bonus! (3 points)

Explain the following results. Please draw a mechanism in 3D as part of your answer.



	1 1A																	18 8A	
1	1 H Hydrogen 1.01	2 2A																	2 He Helium 4.00
2	3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18	
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9	10	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	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	
6	55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)										
				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		
				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)		

Key

11	Atomic number
Na	Element symbol
Sodium	Element name
22.99	Average atomic mass*

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.

TABLE 3.1 Relative Strength of Selected Acids and Their Conjugate Bases

	Acid	Approximate pK_a	Conjugate Base	
Strongest acid	HSbF_6	< -12	SbF_6^-	Weakest base
	HI	-10	I^-	
	H_2SO_4	-9	HSO_4^-	
	HBr	-9	Br^-	
	HCl	-7	Cl^-	
	$\text{C}_6\text{H}_5\text{SO}_3\text{H}$	-6.5	$\text{C}_6\text{H}_5\text{SO}_3^-$	
	$(\text{CH}_3)_2\text{OH}^+$	-3.8	$(\text{CH}_3)_2\text{O}$	
	$(\text{CH}_3)_2\text{C}=\text{OH}^+$	-2.9	$(\text{CH}_3)_2\text{C}=\text{O}$	
	CH_3OH_2^+	-2.5	CH_3OH	
	H_3O^+	-1.74	H_2O	
	HNO_3	-1.4	NO_3^-	
	$\text{CF}_3\text{CO}_2\text{H}$	0.18	CF_3CO_2^-	
	HF	3.2	F^-	
	$\text{C}_6\text{H}_5\text{CO}_2\text{H}$	4.21	$\text{C}_6\text{H}_5\text{CO}_2^-$	
	$\text{C}_6\text{H}_5\text{NH}_3^+$	4.63	$\text{C}_6\text{H}_5\text{NH}_2$	
	$\text{CH}_3\text{CO}_2\text{H}$	4.75	CH_3CO_2^-	
	H_2CO_3	6.35	HCO_3^-	
	$\text{CH}_3\text{COCH}_2\text{COCH}_3$	9.0	$\text{CH}_3\text{COHCOCH}_3$	
	NH_4^+	9.2	NH_3	
	$\text{C}_6\text{H}_5\text{OH}$	9.9	$\text{C}_6\text{H}_5\text{O}^-$	
	HCO_3^-	10.2	CO_3^{2-}	
	CH_3NH_3^+	10.6	CH_3NH_2	
	H_2O	15.7	OH^-	
	$\text{CH}_3\text{CH}_2\text{OH}$	16	$\text{CH}_3\text{CH}_2\text{O}^-$	
	$(\text{CH}_3)_3\text{COH}$	18	$(\text{CH}_3)_3\text{CO}^-$	
	CH_3COCH_3	19.2	$^-\text{CH}_2\text{COCH}_3$	
	$\text{HC}\equiv\text{CH}$	25	$\text{HC}\equiv\text{C}^-$	
	H_2	35	H^-	
	NH_3	38	NH_2^-	
	$\text{CH}_2=\text{CH}_2$	44	$\text{CH}_2=\text{CH}^-$	
Weakest acid	CH_3CH_3	50	CH_3CH_2^-	Strongest base

Increasing acid strength

Increasing base strength