

# CHEM 3331 (Richardson) Midterm Exam 1 – Sep. 26, 2023

Your Name: Key

Student ID: \_\_\_\_\_

Recitation TA (fill in one circle):

- |                            |                         |
|----------------------------|-------------------------|
| O 134 (Alec Kolodziejczyk) | O 142 (Kajal)           |
| O 135 (Alec Kolodziejczyk) | O 143 (Kajal)           |
| O 136 (Lukas Gardner)      | O 144 (James Greenwood) |
| O 137 (Lukas Gardner)      | O 147 (Lukas Gardner)   |
| O 141 (Kyle Fisch)         |                         |

Question	Score	Out of
1		20
2		15
3		15
4		20
5		30
6		10 e.c.
Total		100

This is a closed-book exam, except for one double-sided sheet of 8.5 x 11" paper. The use of calculators or cell phones will not be allowed during the exam. You may use models sets brought in a clear bag. Use the backs of the pages for scratch work. If your final answer is not clearly specified, you will lose points. For mechanisms, show all intermediates including correct formal charges, but do not show transition states.

Periodic Table of the Elements																		
1 IA 1A	2 IIA 2A	3 III B 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VII B 7B	8	9	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
H Hydrogen 1.008	Be Beryllium 9.012	Li Lithium 6.941	Sc Scandium 40.981	Ti Titanium 47.90	Cr Chromium 51.98	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.931	Ni Nickel 58.69	Cu Copper 63.546	Zn Zinc 65.40	B Boron 10.811	C Carbon 12.011	N Nitrogen 14.007	O Oxygen 15.999	F Fluorine 18.998	He Helium 4.003	
K Potassium 39.098	Ca Calcium 40.078	Na Sodium 22.99	Sc Scandium 44.956	Ti Titanium 47.90	Cr Chromium 51.98	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.931	Ni Nickel 58.69	Cu Copper 63.546	Zn Zinc 65.40	Al Aluminum 26.982	Si Silicon 28.085	P Phosphorus 30.974	S Sulfur 32.06	Cl Chlorine 35.45	Ar Argon 39.948	
Rb Rubidium 85.467	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.905	Mo Molybdenum 95.95	Tc Technetium 98.907	Ru Ruthenium 101.07	Rh Rhodium 102.905	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.414	In Indium 114.416	Sn Tin 118.71	Sb Antimony 121.76	Te Tellurium 127.6	Br Bromine 129.914	Kr Krypton 84.798	
Cs Cesium 132.915	Ba Barium 137.32	57-71	Hf Hafnium 178.49	Ta Tantalum 180.549	W Tungsten 183.85	75 Re Rhenium 186.227	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.393	82 Pb Lead 207.2	83 Bi Bismuth 208.984	84 Po Polonium 208.982	85 At Astatine 209.947	86 Rn Radon 222.018	
Fr Francium 223.015	88-103	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 260	107 Bh Bohrium 264	108 Hs Hassium 269	109 Mt Meitnerium 270	110 Ds Darmstadtium 270	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Nh Nihonium 286	114 Fl Flerovium 289	115 Mc Moscovium 288	116 Lv Livermorium 293	117 Ts Tennessine 294	118 Og Oganesson 294		
Lanthanide Series																		
57 La Lanthanum 138.995	58 Ce Cerium 140.116	59 Pr Praseodymium 141.058	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.43	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.939	68 Er Erbium 167.259	69 Tm Thulium 168.924	70 Yb Ytterbium 171.155	71 Lu Lutetium 174.57				
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.035	92 U Uranium 238.929	93 Np Neptunium 237.048	94 Pu Plutonium 244.054	95 Am Americium 243.051	96 Cm Curium 247.073	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium 253	100 Fm Fermium 257.095	101 Md Mendeleyevium 258.1	102 No Nobelium 269.101	103 Lr Lawrencium 272				

## pKa Values

HI	-10	CH <sub>3</sub> COOH	4.7	ArOH	10	HC≡CH	26
HBr	-8	HN <sub>3</sub>	4.7	RSH	10-12	H <sub>2</sub>	35
HCl	-6	H <sub>2</sub> S	7.0	H <sub>2</sub> O	15.7	NH <sub>3</sub>	36
H <sub>3</sub> O <sup>+</sup>	-1.7	NH <sub>4</sub> <sup>+</sup>	9.3	ROH	16-18	H <sub>2</sub> C=CH <sub>2</sub>	45
HF	3.2	HCN	9.4	O=C-CH	9-25	CH <sub>4</sub>	60

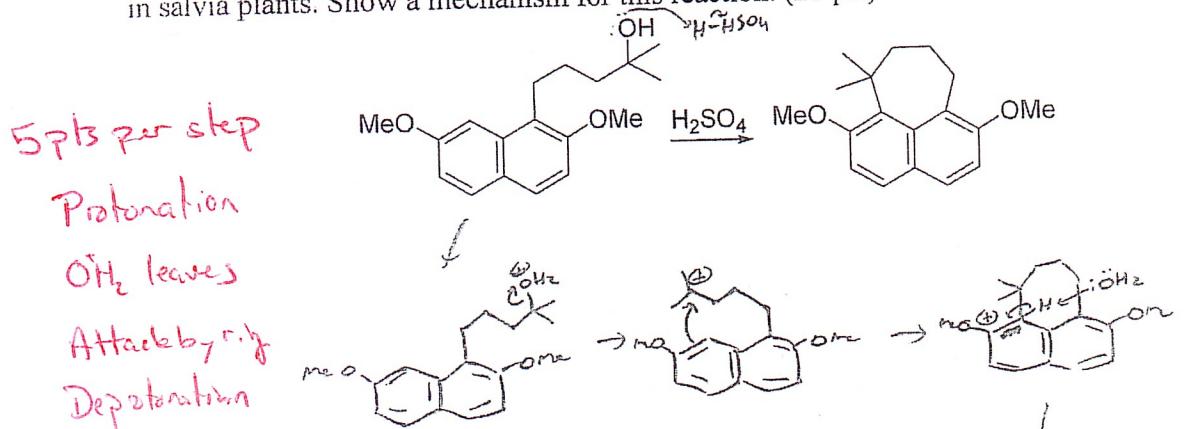
Aug: 62.7

Curci: 12.5

St. Dev: 22.3

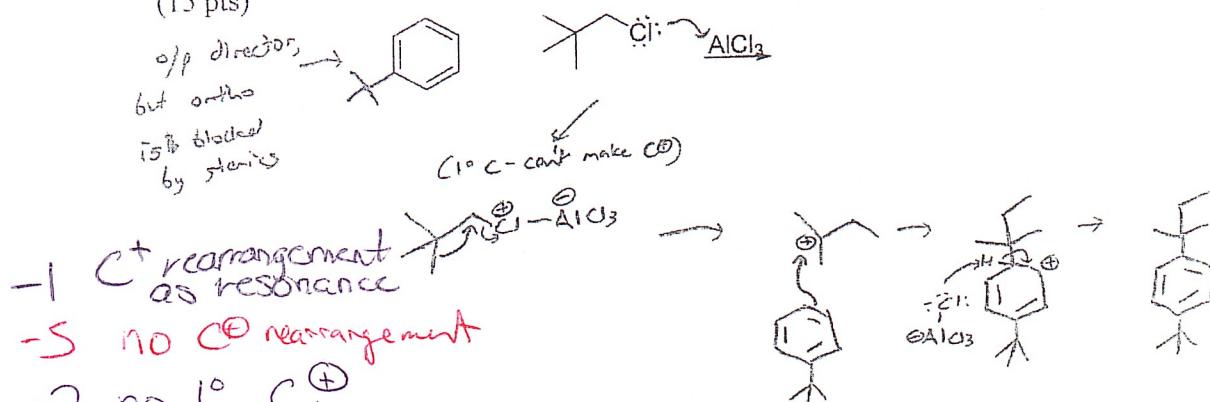
Max: 109

- 1) The reaction shown below was part of a synthesis to create microstegiol, a compound found in salvia plants. Show a mechanism for this reaction. (20 pts)



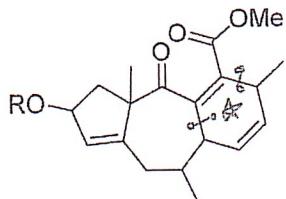
- 1 for missing charges
- 2 for incorrect arrows
- 2 for misc. errors w/ atoms

- 2) Show the mechanism and product for this reaction, assuming only a single addition occurs. (15 pts)



- 3 didn't show Cl to AlCl<sub>3</sub> coordination
- 1 formal charge issues
- 1 meta directing
- 3 non-selective addition of any kind
- 1 AlCl<sub>4</sub><sup>-</sup> as base (from Al<sup>3+</sup> instead of Cl<sup>-</sup>)
- 3 wrong carbocation
- 3 directing effect unclear

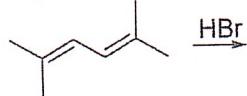
- 3) The molecule below is an intermediate in the synthesis of caribenol A, a molecule with promising anticancer properties. It was recently synthesized via a Diels-Alder reaction. (15 pts total)



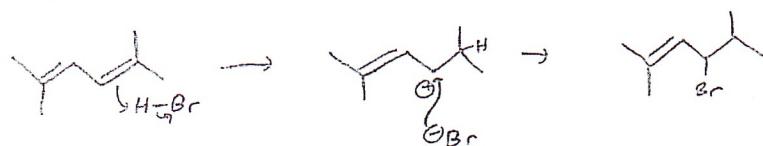
- Draw a star inside the ring which was formed during the Diels-Alder reaction. (1 pts)
- Draw the two disconnect lines ( $\text{---}$ ) across the bonds that were formed during this reaction. (4 pts)
- Draw the precursor molecule that reacted to form this product. (10 pts)



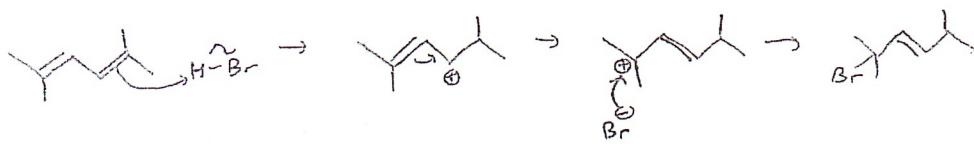
- 4) You perform the reaction shown below, and observe that two products are formed. (20 pts)



- Show a mechanism for the formation of the 1,2-addition product. (8 pts)



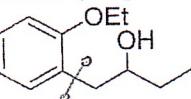
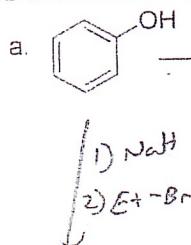
- Show a mechanism for the formation of the 1,4-addition product. (8 pts)



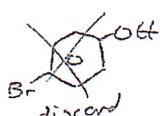
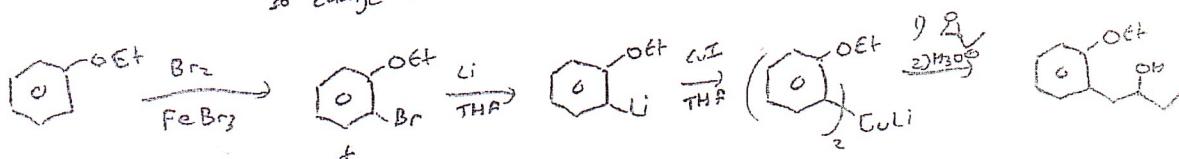
- Which of these gives the more stable final product? (2 pts) 1,2-addition

- Which of these proceeds through the most stable carbocation? (2 pts) 1,4-addition

- 5) Find a way to synthesize the desired product from the given starting material plus any other organic molecules needed. If more than one step is necessary, show the product of each step. Do not show mechanisms. (30 pts - 15 pts each)

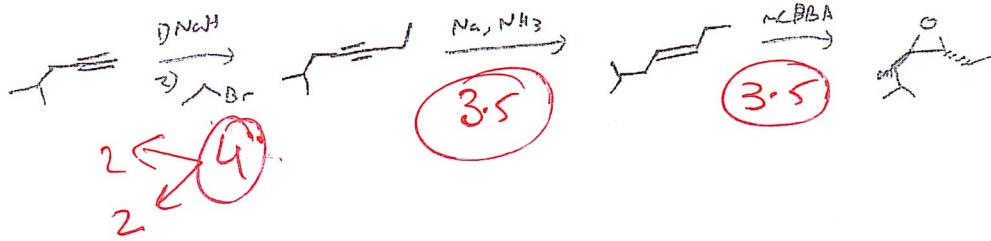
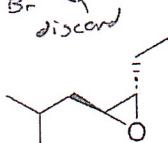


cuprate + epoxide? Need to use  $R_2CuLi$  instead  
of  $RLi$  b/c epoxide has other groups on it. Also  
can't do it with protic group ( $OH$ ) around,  
so change that first.



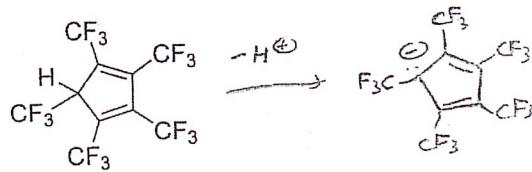
discard

Need trans alkene precursor



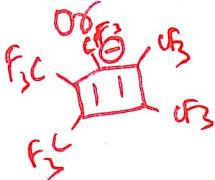
2  
2  
4

- 6) Extra credit! The molecule shown below is an astonishingly strong acid for an organic compound; it has a  $pK_a$  of -2! This is because of two factors that each contribute to the stability of its conjugate base. Explain both of these factors in under thirty words total. (10 pts extra credit)



(2.5)  
Aromatic

4n+2  $\pi$   
 $e^-$   
(2.5)



1) Anion is aromatic ( $6\pi e^-$ )  
2)  $CF_3$  groups further stabilize negative charge

if not mention  $CF_3$ , just inductive -2.5

if just say aromatic & write wrong charge (+ve)

-2.5

-2.5