

CHEM 3331 (Richardson) Midterm Exam 2 – Mar. 12, 2019

Your Name: Key

Student ID: _____

Recitation (check one) O 149 (Thu 5:00 w/ Will)
 O 130 (Wed 8:00 w/ Olivia) O 235 (Wed 1:00 w/ Lauren)
 O 134 (Wed 12:00 w/ Olivia) O 237 (Wed 3:00 w/ Lauren)
 O 136 (Wed 2:00 w/ Lacey) O 239 (Wed 5:00 w/ Zepeng)
 O 138 (Wed 4:00 w/ Lacey) O 240 (Thu 8:00 w/ Zhenhao)
 O 141 (Thu 9:00 w/ Chance) O 242 (Thu 10:00 w/ Lauren)
 O 143 (Thu 11:00 w/ Chance) O 244 (Thu 12:00 w/ Lauren)
 O 145 (Thu 1:00 w/ Lacey) O 246 (Thu 2:00 w/ Brianna)
 O 147 (Thu 3:00 w/ Will) O 248 (Thu 4:00 w/ Brianna)

Question	Score	Out of
1		16
2		14
3		30
4		20
5		5
6		15
8		10 e.c.
Total		100

This is a closed-book exam. The use of notes, 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.

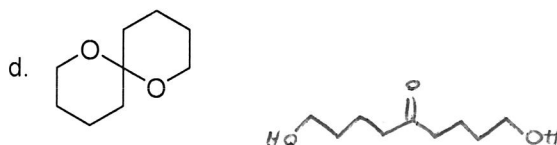
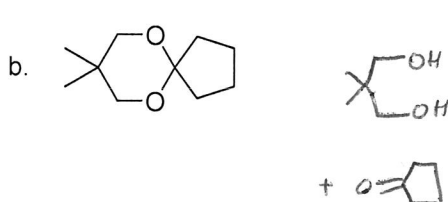
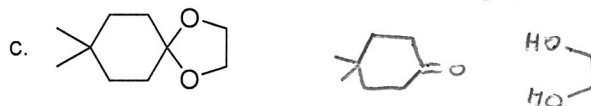
																18 VIII 8A																																			
																2 He Helium 4.003																																			
																13 IIIA 3A		14 IVA 4A		15 VA 5A		16 VIA 6A		17 VIIA 7A																											
																5 B Boron 10.811		6 C Carbon 12.011		7 N Nitrogen 14.007		8 O Oxygen 15.999		9 F Fluorine 18.998		10 Ne Neon 20.180																									
																11 Na Sodium 22.990		12 Mg Magnesium 24.305		13 Al Aluminum 26.982		14 Si Silicon 28.086		15 P Phosphorus 30.974		16 S Sulfur 32.065		17 Cl Chlorine 35.453		18 Ar Argon 39.948																					
																19 K Potassium 39.098		20 Ca Calcium 40.078		21 Sc Scandium 44.956		22 Ti Titanium 47.88		23 V Vanadium 50.942		24 Cr Chromium 51.996		25 Mn Manganese 54.938		26 Fe Iron 55.845		27 Co Cobalt 58.933		28 Ni Nickel 58.693		29 Cu Copper 63.546		30 Zn Zinc 65.38		31 Ga Gallium 69.723		32 Ge Germanium 72.631		33 As Arsenic 74.922		34 Se Selenium 78.971		35 Br Bromine 79.904		36 Kr Krypton 83.796	
																37 Rb Rubidium 85.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906		40 Zr Zirconium 91.224		41 Nb Niobium 92.906		42 Mo Molybdenum 95.95		43 Tc Technetium 98.907		44 Ru Ruthenium 101.07		45 Rh Rhodium 102.906		46 Pd Palladium 106.42		47 Ag Silver 107.868		48 Cd Cadmium 112.414		49 In Indium 114.818		50 Sn Tin 118.710		51 Sb Antimony 121.760		52 Te Tellurium 127.6		53 I Iodine 126.905		54 Xe Xenon 131.29	
																55 Cs Cesium 132.905		56 Ba Barium 137.327		57-71 Lanthanide Series		72 Hf Hafnium 178.49		73 Ta Tantalum 180.948		74 W Tungsten 183.85		75 Re Rhenium 186.207		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 204.383		82 Pb Lead 207.2		83 Bi Bismuth 208.980		84 Po Polonium 209		85 At Astatine 210		86 Rn Radon 222	
																87 Fr Francium 223		88 Ra Radium 226		89-103 Actinide Series		104 Rf Rutherfordium 261		105 Db Dubnium 262		106 Sg Seaborgium 266		107 Bh Bohrium 264		108 Hs Hassium 277		109 Mt Meitnerium 268		110 Ds Darmstadtium 271		111 Rg Roentgenium 272		112 Cn Copernicium 285		113 Nh Nihonium 284		114 Fl Flerovium 289		115 Mc Moscovium 288		116 Lv Livermorium 293		117 Ts Tennessine 294		118 Og Oganesson 294	
																57 La Lanthanum 138.905		58 Ce Cerium 140.116		59 Pr Praseodymium 140.908		60 Nd Neodymium 144.24		61 Pm Promethium 144.913		62 Sm Samarium 150.36		63 Eu Europium 151.964		64 Gd Gadolinium 157.25		65 Tb Terbium 158.925		66 Dy Dysprosium 162.500		67 Ho Holmium 164.930		68 Er Erbium 167.255		69 Tm Thulium 168.934		70 Yb Ytterbium 173.055		71 Lu Lutetium 174.967							
																89 Ac Actinium 227.028		90 Th Thorium 232.038		91 Pa Protactinium 231.036		92 U Uranium 238.029		93 Np Neptunium 237.048		94 Pu Plutonium 244.064		95 Am Americium 243.061		96 Cm Curium 247.070		97 Bk Berkelium 247.070		98 Cf Californium 251.080		99 Es Einsteinium 252.083		100 Fm Fermium 257.103		101 Md Mendelevium 258.10		102 No Nobelium 259.108		103 Lr Lawrencium 262.109							

pKa Values

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

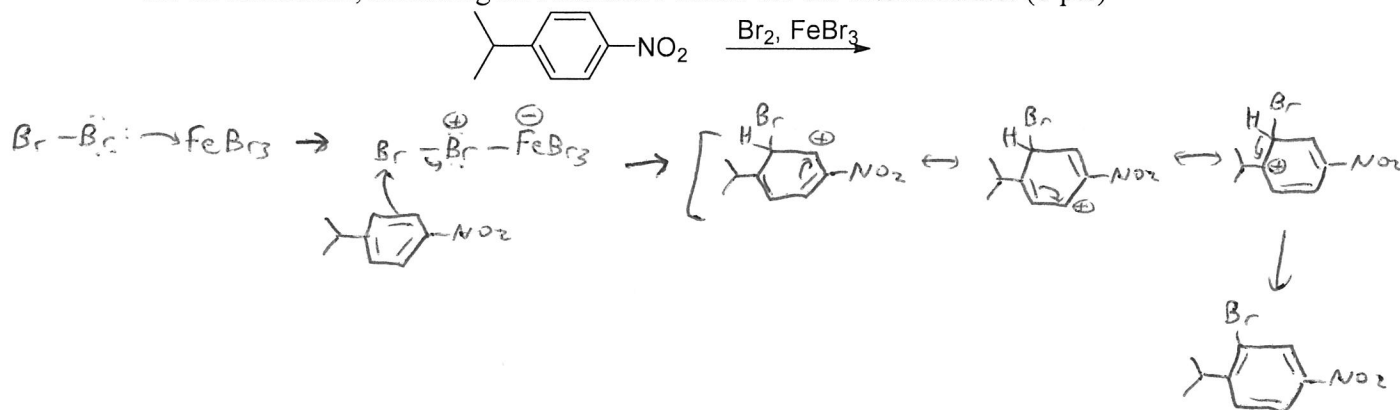
Average: 72.4
 St. Dev: 20.3
 Max: 109
 Min: 6

1) Show the product(s) formed if these compounds were exposed to H_3O^+ and heat. (16 pts)

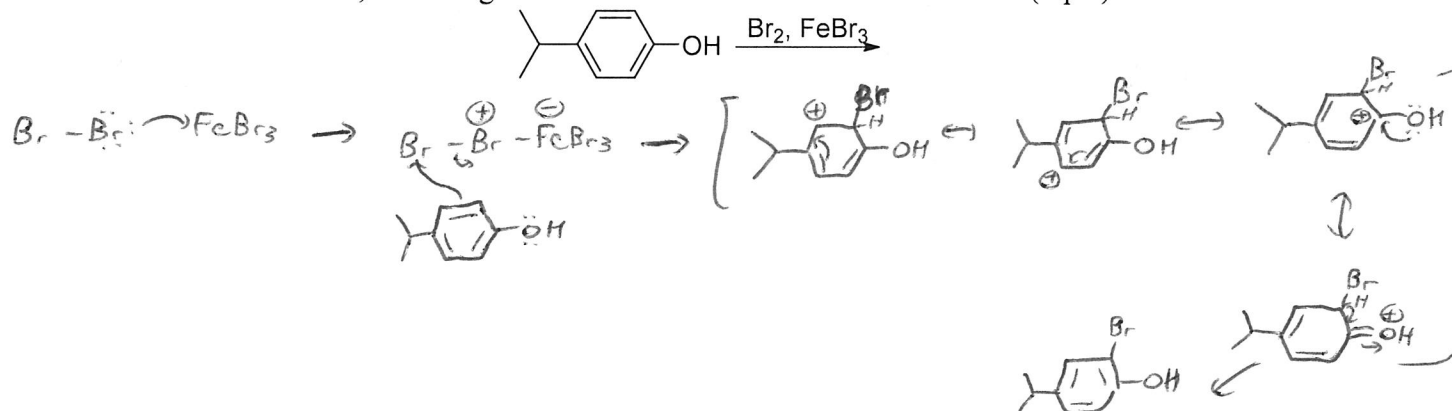


2) The directing effects of groups during electrophilic aromatic substitution reactions can be explained by resonance. (14 pts)

a. The reaction below produces a single isomer as the major product. Show the mechanism for its formation, including all resonance forms for the intermediate. (6 pts)



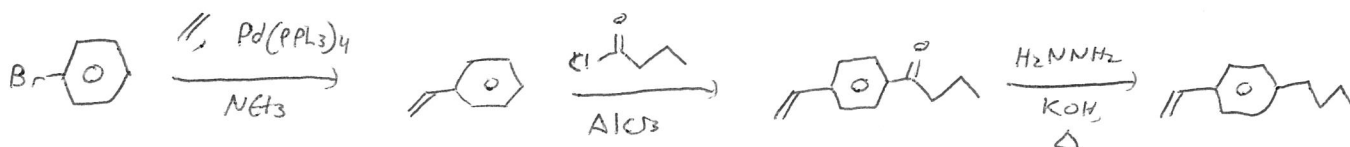
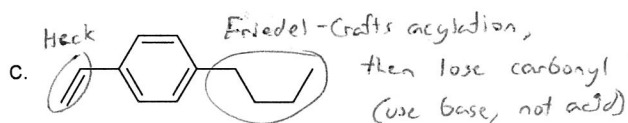
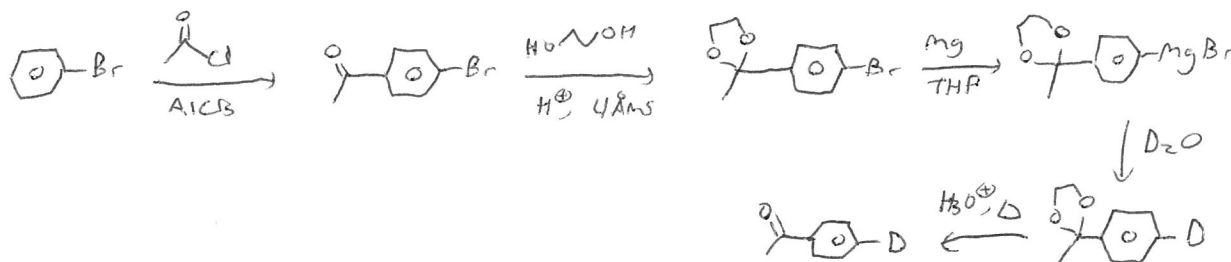
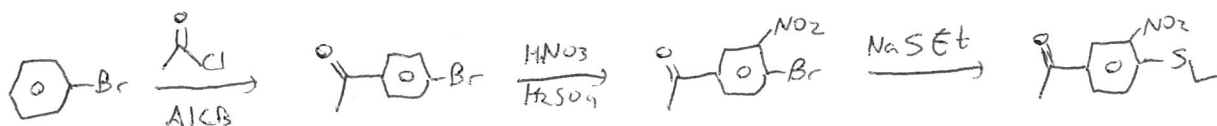
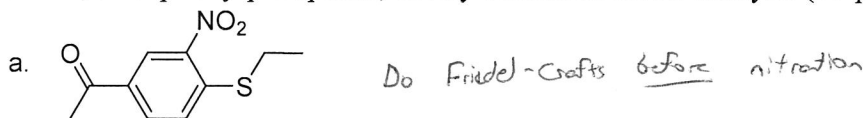
b. The reaction below produces a single isomer as the major product. Show the mechanism for its formation, including all resonance forms for the intermediate. (6 pts)



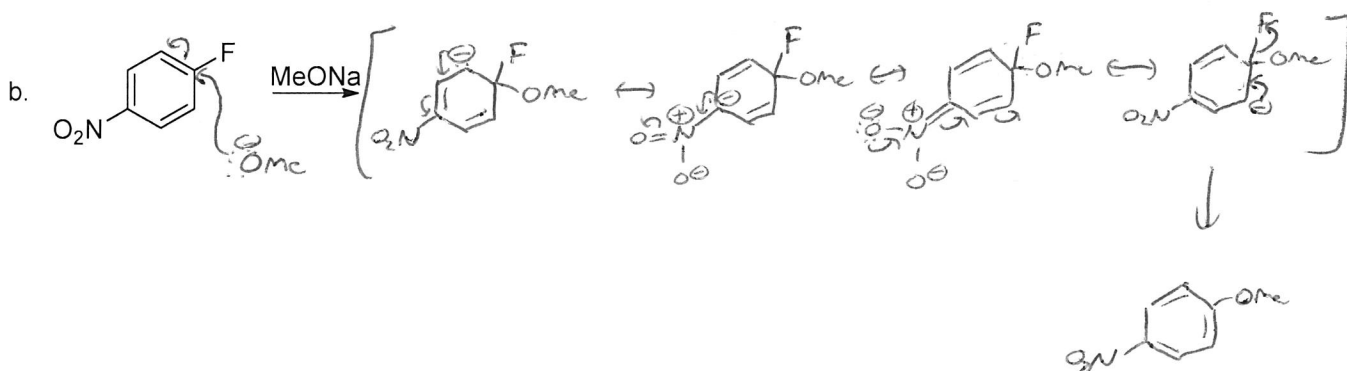
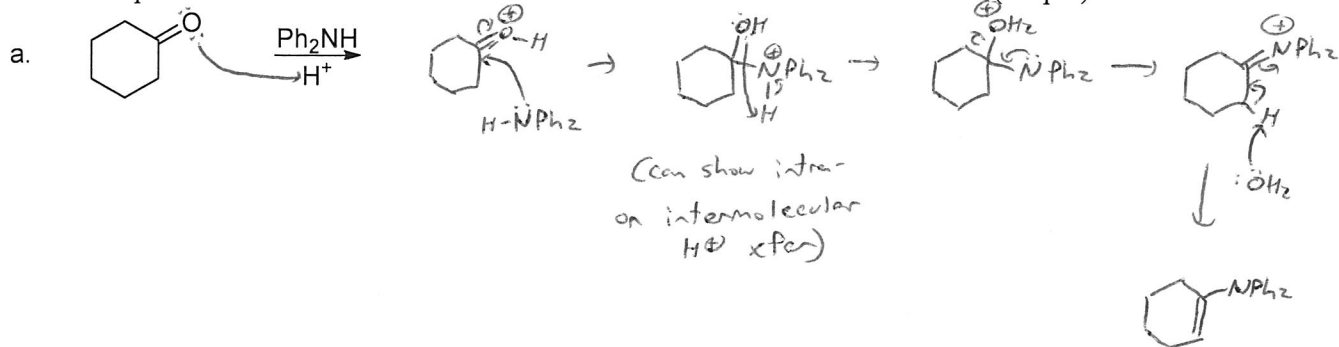
c. Which reaction would be faster? (2 pts)

b) OH is a stronger activating group.

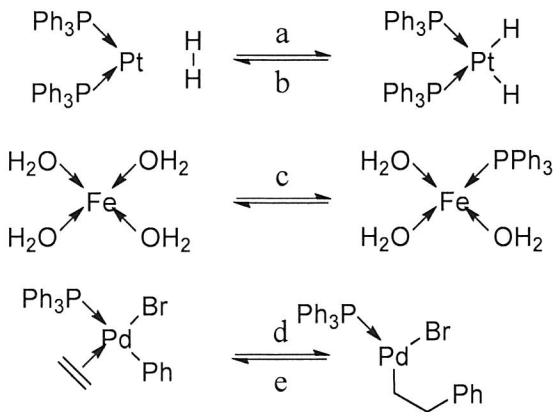
- 3) Find a way to synthesize the desired product from any reagents containing at most six carbon atoms, or triphenylphosphine, or any transition metal catalyst. (30 pts)



4) Show the products of these reactions and the mechanism for their formation. (20 pts).



5) Label each of these basic transition metal-ligand reaction steps. (5 pts)



Describe each step:

a. oxidative insertion

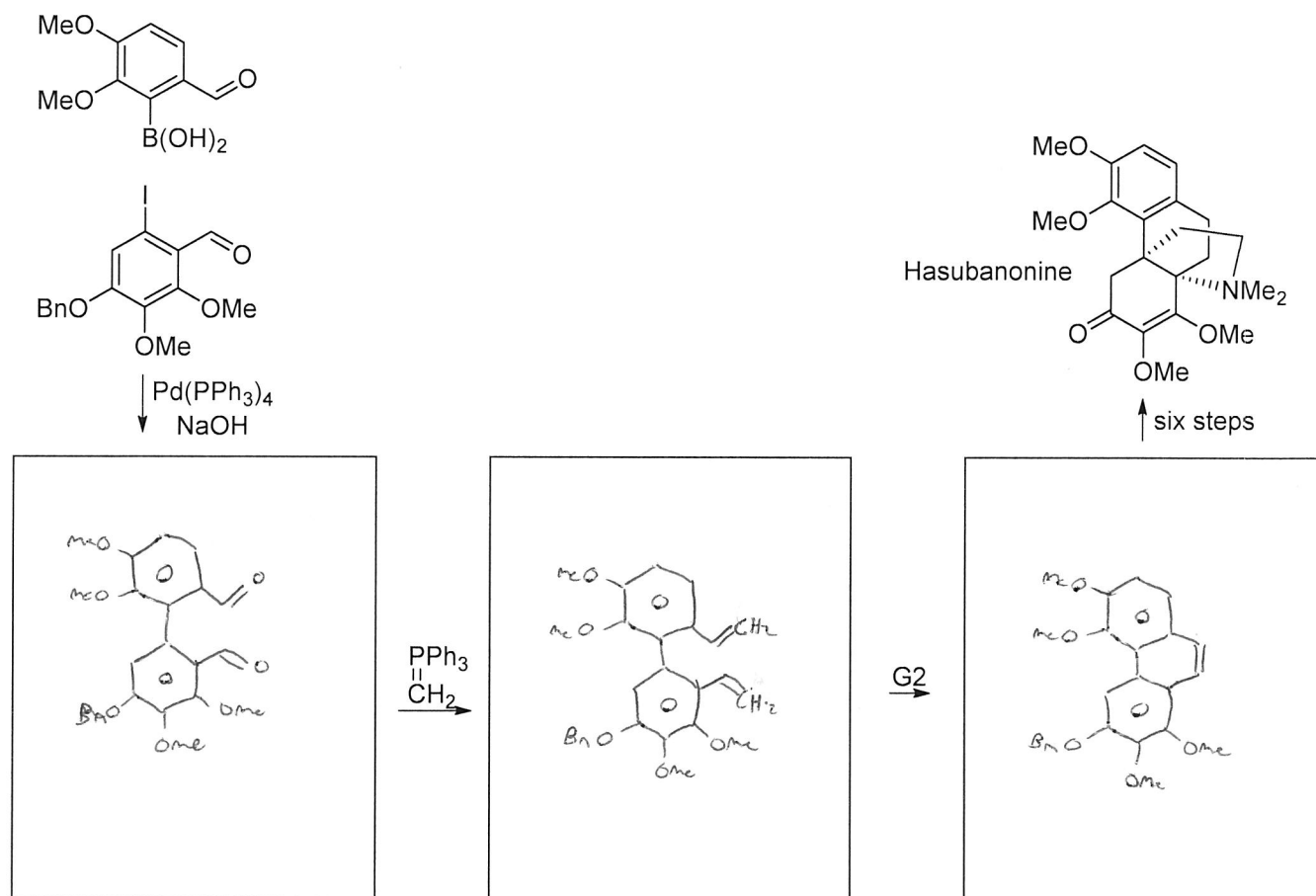
b. reductive elimination

c. ligand substitution

d. ligand insertion

e. β -elimination

6) Hasubanonine was recently synthesized by the following route. Fill in the boxes. (15 pts)



7) Extra credit! A hydrocarbon A, C_9H_{10} , is treated with N-bromosuccinimide to give a single monobromo compound B. When B is dissolved in aqueous acetone it reacts to give two nonisomeric compounds: C and D. Catalytic hydrogenation of D gives back A, and C can be separated into enantiomers. When optically active C is oxidized with CrO_3 and pyridine, an optically inactive ketone E is obtained. Vigorous oxidation of A with KMnO_4 affords phthalic acid (shown below). Propose structures for compounds A through E, and explain your reasoning. (10 pts e.c.)

