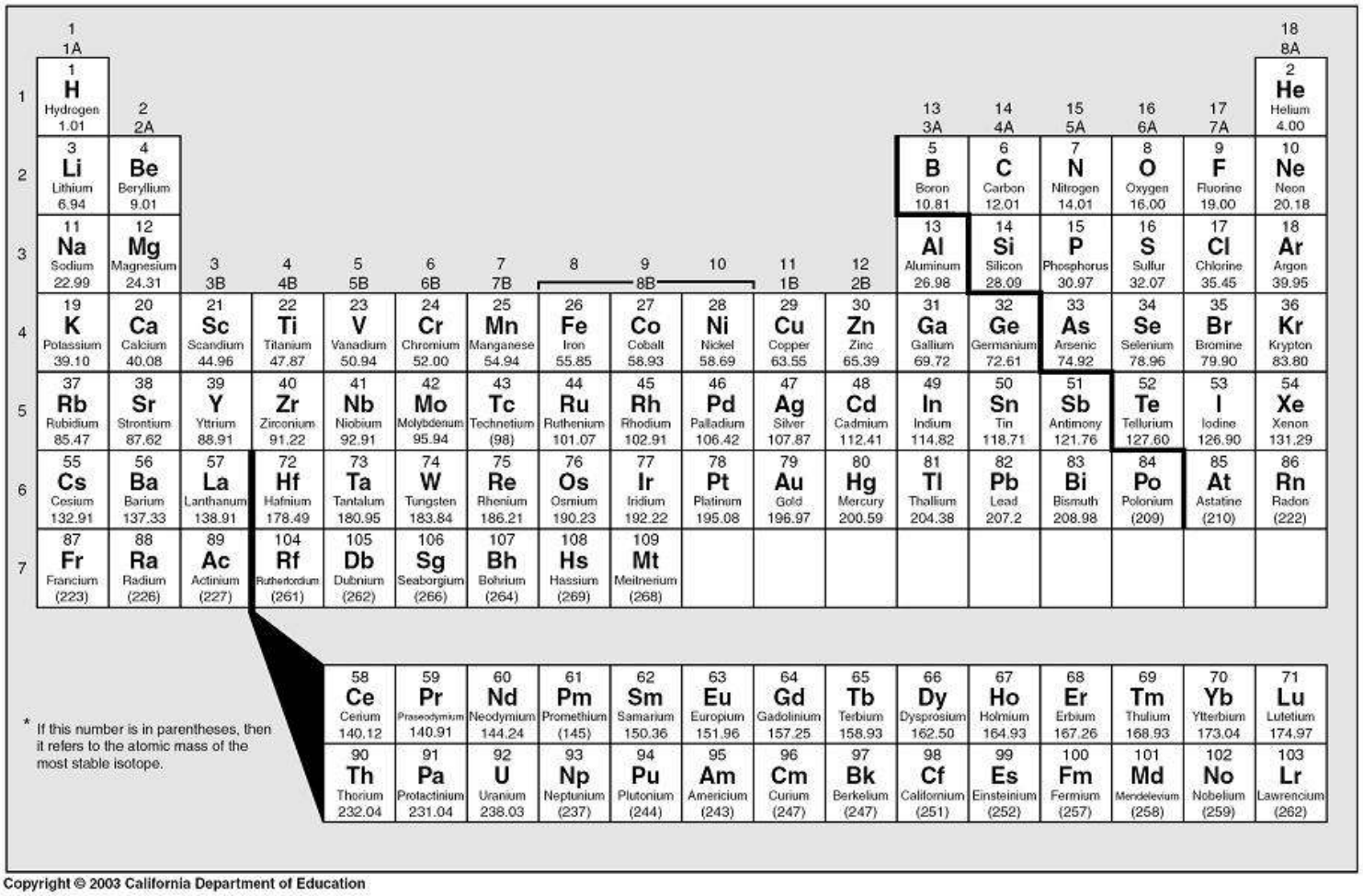
CHEMISTRY 302
EXAM 1
8:00 AM / SECTION 1
20 Feb 2009

Name: _____

Note: Your exam should consist of 6 pages including the cover page and grade tabulation sheet. Skim the entire exam, and solve the easiest problems first. Exams not returned when time is called will not be graded.



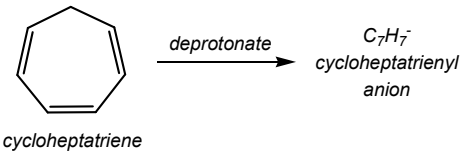
	1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 H Hydrogen 1.01	2 2A																2 He Helium 4.00
2	3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	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)

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

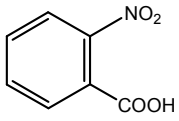
PLEASE DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO.

1. (8 pts) Would you expect cycloheptatrienyl anion to be aromatic on the basis of the electron distribution in its π molecular orbitals? First, draw the structure of the cycloheptatrienyl anion. Then, **briefly** explain using a combination of polygon/circle diagram and words.

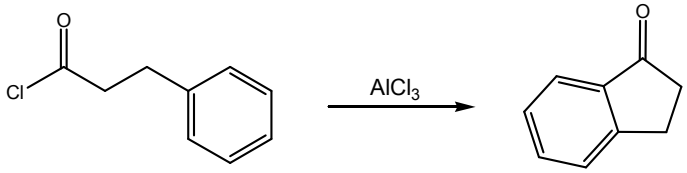


cycloheptatriene

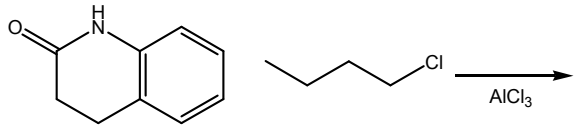
2. (12 pts) Starting from **<u>toluene</u>** and whatever reagents you might need, show how you would synthesize the molecule to the right. You do not need to show the mechanisms of the transformations.

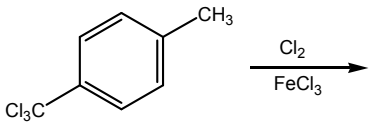


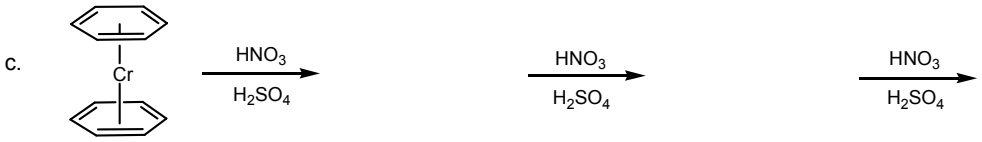
3. (12 pts) Provide a complete mechanism for the following reaction. *If an intermediate or product is resonance stabilized, it is necessary to show only ONE structure; you do not need to show all possible resonance structures.*



4. (18 pts) Predict the major product for each of the following reactions.

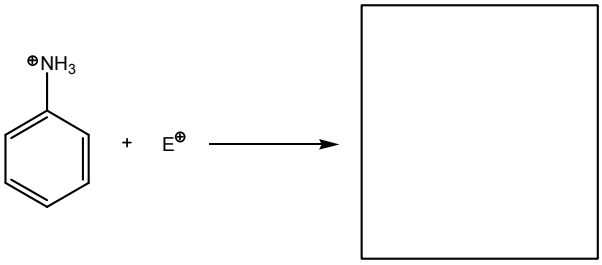
a. 

b. 

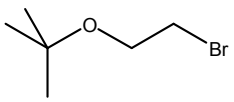
c. 

a cousin of ferrocene: a Cr sandwiched between two benzenes

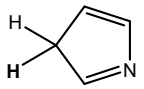
5. (10 pts) Is the NH_3^+ group an *o,p*-director or a *m*-director? Draw **one** resonance structure for the carbocation intermediate in the box below that is crucial to justifying your answer. **Briefly** explain the significance of that structure.



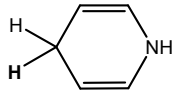
6. (10 pts) Predict what the ^1H NMR spectrum will look like for the molecule shown below:
(i) Label the magnetically different H's as a, b, …
(ii) Give the expected relative areas expected for a : b : …
(iii) Indicate which signal is most deshielded.
(iv) Indicate the splitting pattern (singlet, doublet, etc) expected for each signal.



7. (10 pts) Predict which compound is most acidic (consider the protons in bold). **Briefly** explain your choice using a combination of drawings and words.



1



2

8. (20 pts) Shown below are ^{1}H NMR, ^{13}C NMR, and mass spectra for an unknown compound **BLAZE** that has the molecular formula $C_{10}H_{12}O_2$. Propose a structure for **BLAZE** using the data provided. Draw your proposed structure in the box below.

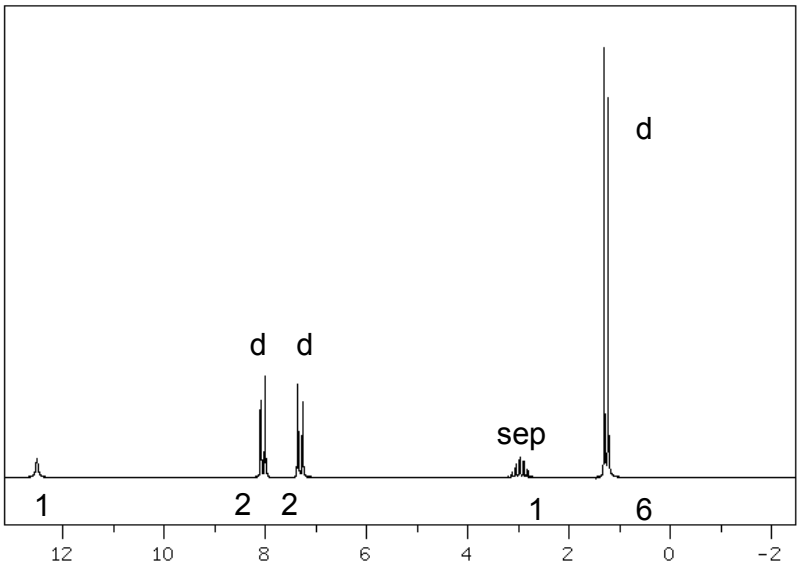
For full credit, you must do the following:

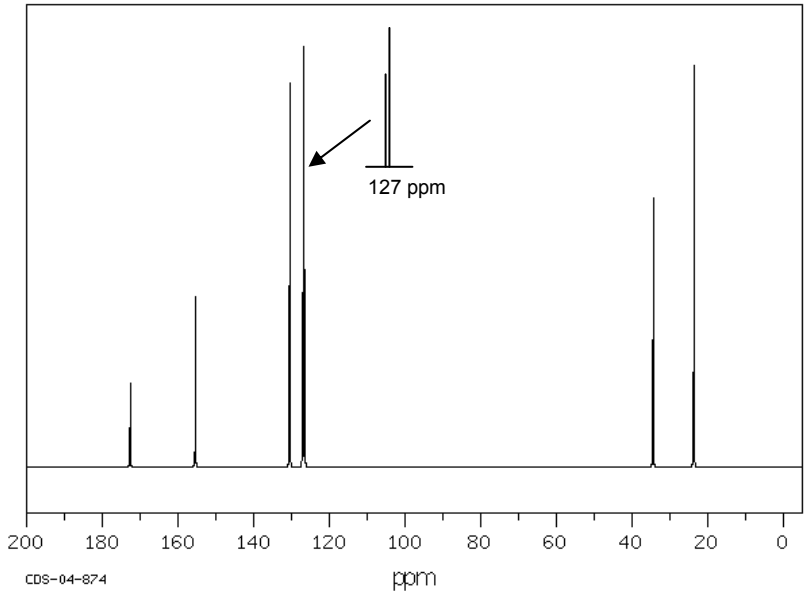
a. Calculate the IHD.
b. Assign all signals in the ^{1}H NMR spectrum (a, b, etc) to labeled protons in the structure.
c. Show that the splitting pattern of two of the signals is consistent with your structure.
d. Assign all signals in the ^{13}C NMR spectrum (A, B, etc) to labeled carbons in the structure. Think reasonable.
e. Write "base peak" and "molecular ion" next to the corresponding signal(s) in the MS.

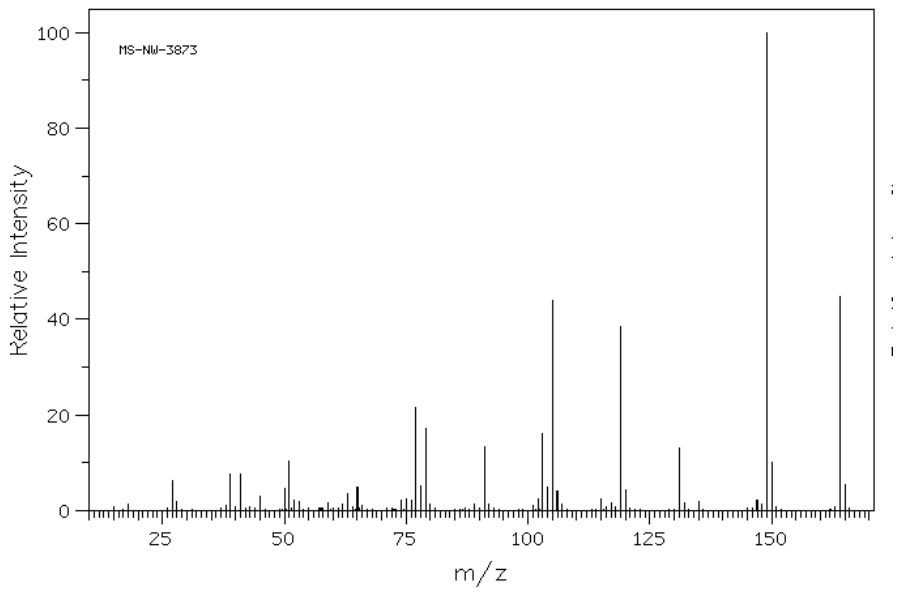
BLAZE

BLAZE

$C_{10}H_{12}O_2$







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Page	Points	Score
2	32	
3	38	
4	30	
Total	100