

University of Windsor
Chemistry and Biochemistry

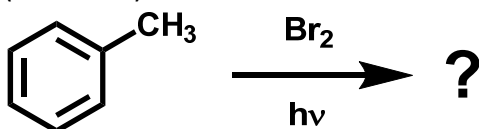
Chemistry 59-235
First Test

Feb. 10, 2015
Time: 52 minutes

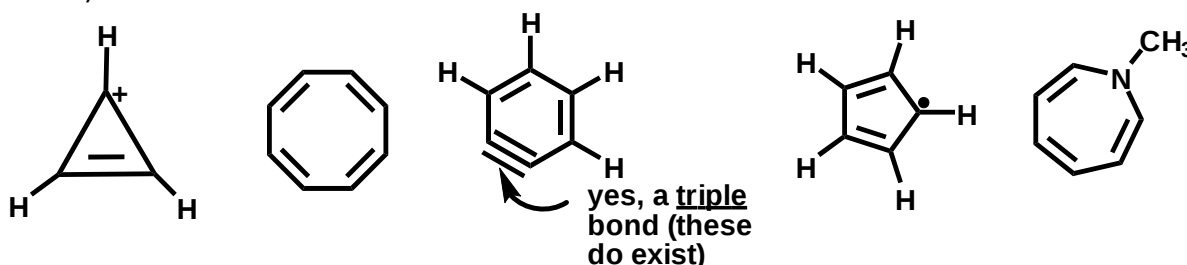
Note: There are questions **on both sides** of this page.

Note: Please write in exam booklets. Tests written in pencil will be marked, but cannot be returned for remarking.

1. Give the **complete** mechanism for the following bromination of toluene. The complete answer will include a reasonable initiation step, the propagation steps, and one reasonable termination step. The product is also required. Multiple resonance forms of the reactive intermediate are *not* mandatory, but if they're drawn they must be correct. (15 marks)

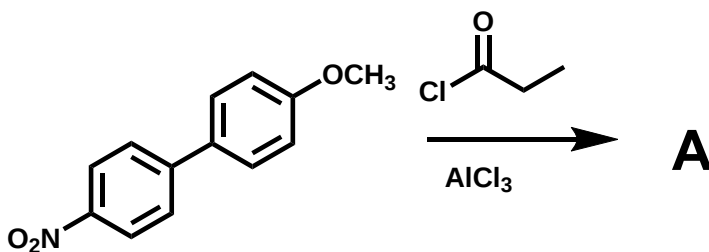


2. Indicate whether the following systems are aromatic, antiaromatic, or non-aromatic by Hückel's Rule, **and** give the number of π - electrons in the *conjugated* cyclic system (5 marks)



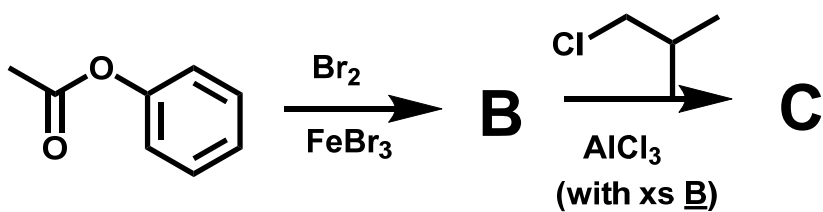
3. Predict the most reasonable structure of the major product(s) from each of the following reactions. Mechanisms are not necessary, but showing your work is likely to be a help. *Note: If there is >1 significant product, show them all and take the **major** one on to any further step. Note 2. In complex substituents such as sulfonic acid, nitro groups and diazonium salts, the correct valence bond structure must be drawn (at least) one time.* (5 marks for each letter, 30 marks total).

a)

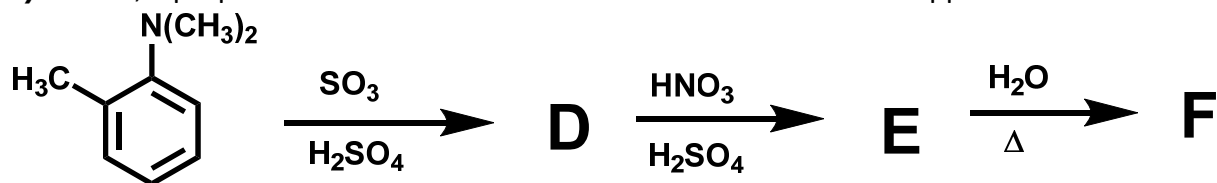


for complete marks, one proper valence bond structure of the nitro group is required somewhere in the exam

b)

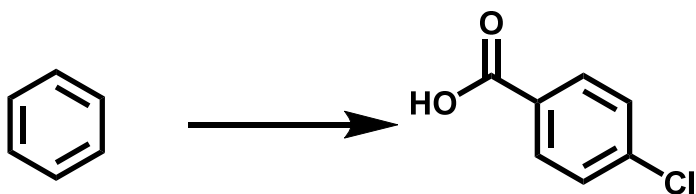


c) Also, a proper valence bond structure for the sulfonic acid must appear somewhere.

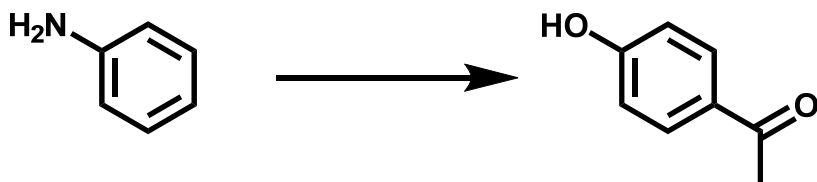


4. Show by equation (in one or several steps) how you could prepare the illustrated products from the given starting material. You may use any other reagents which you deem fit. Show all reagents, conditions, and intermediates which could be isolated. I also wish to see an appropriate valence bond structure for complex substituents such as sulfonic acids, at least one time. Mechanisms are not necessary, but may be a help (**10 marks each, 20 marks total**).

a.



b.



WebElements: the periodic table on the world-wide web

<http://www.webelements.com/>

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
hydrogen 1 H 1.00794(7)																	helium 2 He 4.002602(2)	
lithium 3 Li 6.941(2)	beryllium 4 Be 9.012182(3)	Key: element name atomic number symbol 2001 atomic weight (mean relative mass)											boron 5 B 10.811(7)	carbon 6 C 12.0107(8)	nitrogen 7 N 14.00674(7)	oxygen 8 O 15.9994(3)	fluorine 9 F 18.9984032(5)	neon 10 Ne 20.1797(6)
sodium 11 Na 22.989770(2)	magnesium 12 Mg 24.3050(6)											aluminium 13 Al 26.981538(2)	silicon 14 Si 28.0855(3)	phosphorus 15 P 30.973761(2)	sulfur 16 S 32.065(5)	chlorine 17 Cl 35.453(2)	argon 18 Ar 39.948(1)	
potassium 19 K 39.0983(1)	calcium 20 Ca 40.078(4)	scandium 21 Sc 44.955910(8)	titanium 22 Ti 47.867(1)	vanadium 23 V 50.9415(1)	chromium 24 Cr 51.9961(6)	manganese 25 Mn 54.938049(9)	iron 26 Fe 55.845(2)	cobalt 27 Co 58.933200(9)	nickel 28 Ni 58.6934(2)	copper 29 Cu 63.546(3)	zinc 30 Zn 65.409(4)	gallium 31 Ga 69.723(1)	germanium 32 Ge 72.64(1)	arsenic 33 As 74.92160(2)	selenium 34 Se 78.96(3)	bromine 35 Br 79.904(1)	krypton 36 Kr 83.798(2)	
rubidium 37 Rb 85.4678(3)	strontium 38 Sr 87.62(1)	yttrium 39 Y 88.90585(2)	zirconium 40 Zr 91.224(2)	niobium 41 Nb 92.90638(2)	molybdenum 42 Mo 95.94(1)	technetium 43 Tc [98]	ruthenium 44 Ru 101.07(2)	rhodium 45 Rh 102.90550(2)	palladium 46 Pd 106.42(1)	silver 47 Ag 107.8682(2)	cadmium 48 Cd 112.411(8)	indium 49 In 114.818(3)	tin 50 Sn 118.710(7)	antimony 51 Sb 121.760(1)	tellurium 52 Te 127.60(3)	iodine 53 I 126.90447(3)	xenon 54 Xe 131.293(6)	
caesium 55 Cs 132.90545(2)	barium 56 Ba 137.327(7)	57-70 *	lutetium 71 Lu 174.967(1)	hafnium 72 Hf 178.49(2)	tantalum 73 Ta 180.9479(1)	tungsten 74 W 183.84(1)	rhenium 75 Re 186.207(1)	osmium 76 Os 190.23(3)	iridium 77 Ir 192.217(3)	platinum 78 Pt 195.078(2)	gold 79 Au 196.96655(2)	mercury 80 Hg 200.59(2)	thallium 81 Tl 204.3833(2)	lead 82 Pb 207.2(1)	bismuth 83 Bi 208.98038(2)	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unbibium 112 Uub [285]		ununquadium 114 Uuq [289]				

lanthanum 57 La 138.9055(2)	cerium 58 Ce 140.116(1)	praseodymium 59 Pr 140.90765(2)	neodymium 60 Nd 144.24(3)	promethium 61 Pm [145]	samarium 62 Sm 150.36(3)	europium 63 Eu 151.964(1)	gadolinium 64 Gd 157.25(3)	terbium 65 Tb 158.92534(2)	dysprosium 66 Dy 162.500(1)	holmium 67 Ho 164.93032(2)	erbium 68 Er 167.259(3)	thulium 69 Tm 168.93421(2)	ytterbium 70 Yb 173.04(3)
actinium 89 Ac [227]	thorium 90 Th 232.0381(1)	protactinium 91 Pa 231.03588(2)	uranium 92 U 238.02891(3)	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

*lanthanoids

**actinoids

Element symbols and names, symbols, names, and spellings are those recommended by IUPAC (<http://www.iupac.org>). After controversy, the names of elements 101-109 are now confirmed (Pure & Appl. Chem., 1997, 69, 2471-2473). Names have yet to be proposed for the elements 110-112, and 114 - those used here are IUPAC's temporary systematic names (Pure & Appl. Chem., 1979, 51, 381-384). In the USA and some other countries, the spellings **aluminum** and **cesium** are normal while in the UK and elsewhere the usual spelling is **sulphur**. Atomic weights (mean relative masses): Apart from the heaviest elements, these are IUPAC 2001 values (Pure & Appl. Chem., 2001, 73, 667-683). Elements with values given in brackets have no stable nuclides and are represented by 5-figure values for the longest-lived isotope. The elements (thorium, protactinium, and uranium) have characteristic terrestrial abundances and these are the values quoted. The last significant figure of each value is considered reliable to ± 1 except where a larger uncertainty is given in parentheses. Periodic table organization: for a justification of the positions of the elements La, Ac, Lu, and Lr in the WebElements periodic table see W.B. Jensen. The positions of lanthanum (actinium) and lutetium (lawrencium) in the periodic table. J. Chem. Ed. 1982, 59, 634-636. Group labels: the numeric system (1-18) used here is the current IUPAC convention. For a discussion of this and other common systems see: W.C. Fernelius and W.H. Powell, Confusion in the periodic table of the elements. J. Chem. Ed. 1962, 39, 504-508.

WebElements is a joint venture between the University of Cambridge, UK, and the University of Houston, USA. It is a non-profit organization and its activities are supported by the University of Cambridge and the University of Houston.