CHEMISTRY 2323: Fundamentals of Organic Chemistry I First Midterm Exam

Prof. Ognjen Š. Miljanić September 24, 2021

Name: _____ Student ID Number: _____

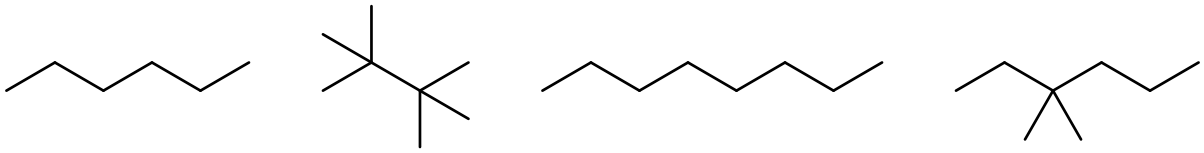
(print legibly) Last First

Read all directions very carefully. Write your answer legibly in the designated spaces and think carefully about what you are doing. Total number of points is 300. This exam is supposed to have eight pages, with the last two pages intentionally left blank.

1. This question has several parts. In each, **circle only one entry**.

Circle <u>a compound with the highest boiling point</u>: *5×6 = 30 points*

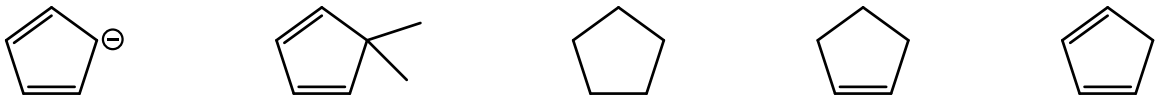
Textbook question 3-10 (Wade, 9th edition)



The bond dissociation energy of a Cl—Cl bond is approximately:

0.05 kcal/mol 0.5 kcal/mol 5 kcal/mol 50 kcal/mol 500 kcal/mol

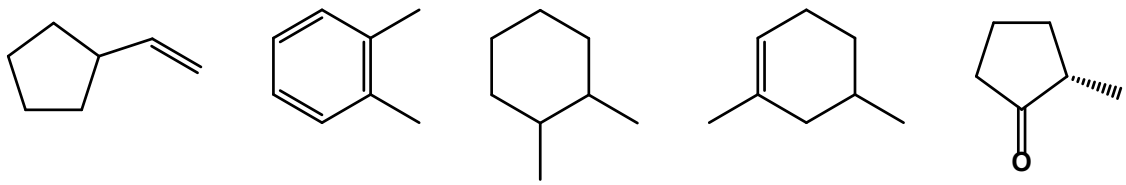
Circle <u>the strongest acid</u>:



An equilibrium constant (K_{eq}) of approx. 150 corresponds to a ΔG^0 of approximately:

0.3 kcal/mol −0.3 kcal/mol 3 kcal/mol −3 kcal/mol 300 kcal/mol

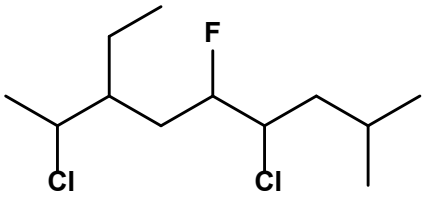
Circle <u>the only aromatic hydrocarbon</u>:

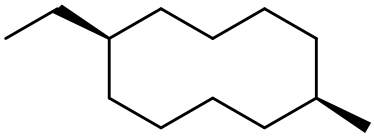


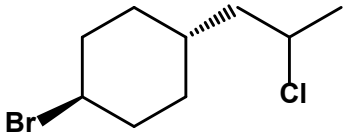
DO NOT WRITE IN THIS SPACE

FINAL SCORE

2. For each of the following structures, give a **complete systematic IUPAC name**. Be sure to indicate stereochemistry where this is pertinent. *3×15 = 45 points*

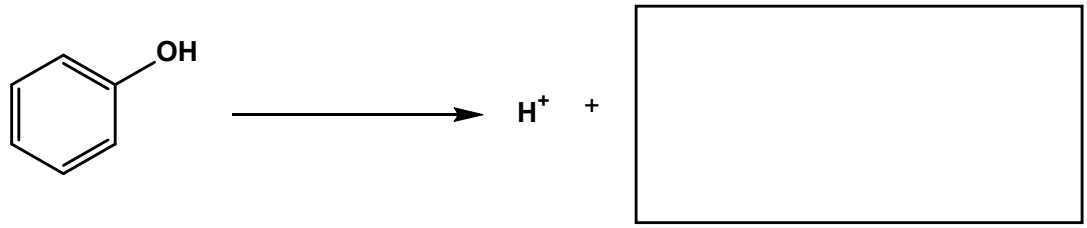




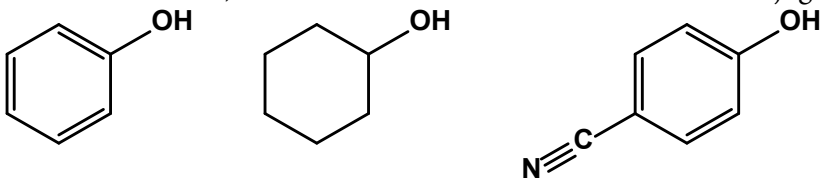


3. Use a Newman projection about the indicated bond to draw the most stable conformer for each compound:
(*a*) 3-methylpentane about the C2—C3 bond (*b*) 3,3-dimethylhexane about the C3—C4 bond
Textbook question 3-44 (Wade, 9th edition)
40 points

4. Let's talk about acidity. Strong acids are inherently unstable compounds, because they tend to lose protons very easily. In doing so, they *dissociate* into a proton and their *conjugate bases*. For the acid shown below, complete the equation of its deprotonation: *60 points*

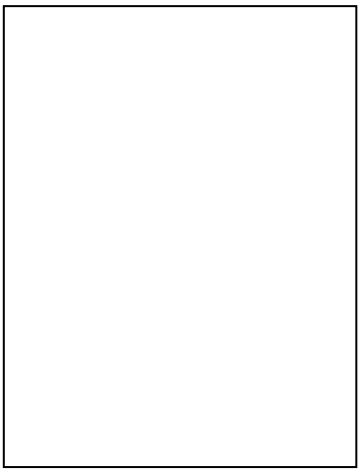


Conjugate bases of strong acids are stable compounds (and therefore weak bases) which have a minimal desire to take the proton back. Figuring out whether an acid is strong or weak is more easily done by looking at its conjugate base. A stable conjugate base means that the corresponding acid was strong, and an unstable conjugate base means that the corresponding acid was weak. One way of stabilizing conjugate bases is resonance. For the three acids below, write all the resonance structures of their conjugate bases:



Now go back and circle the strongest acid of the three. Remember, it will be the one with the most stable conjugate base.

5. In the box on the left, draw the formula of all-*cis*-1,3-dichloro-2-methylcyclohexane (all-*cis* means that all three groups will be on the same side of the ring). Then, in the rest of the provided space, draw the two chair conformations of this molecule and circle the more stable one. Equatorial preferences are 0.5 kcal/mol for the chlorine and 1.8 kcal/mol for the methyl substituent. *50 points*



6. Bromine reacts with methane to produce bromomethane. Write out both propagation steps in this reaction:
50 points

STEP 1:

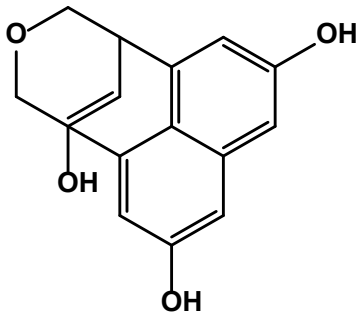
STEP 2:

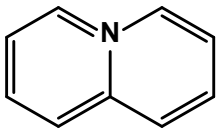
Calculate the ΔH^0 for both propagation steps of this reaction in kcal/mol. Consult the table ona page 6 for specific bod dissociation energies (BDEs), and show your work. For each step, specify whether the reaction is exothermic or endothermic.

STEP 1:

STEP 2:

7. There is something very wrong with one of the atoms in each of the three structures below. Circle the problematic atom in each structure and explain—in five words or less—what the problem is with each of those troubled atoms.
30 points





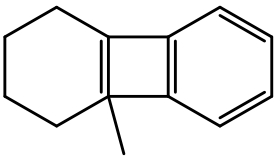


TABLE 4-2 Bond-Dissociation Enthalpies for Homolytic Cleavages

$A{:}B \longrightarrow A\cdot + \cdot B$

Bond	Bond-Dissociation Enthalpy kJ/mol	Bond-Dissociation Enthalpy kcal/mol
H—X bonds and X—X bonds		
H—H	435	104
D—D	444	106
F—F	159	38
Cl—Cl	242	58
Br—Br	192	46
I—I	151	36
H—F	569	136
H—Cl	431	103
H—Br	368	88
H—I	297	71
HO—H	498	119
HO—OH	213	51
Methyl bonds		
CH_3—H	435	104
CH_3—F	456	109
CH_3—Cl	351	84
CH_3—Br	293	70
CH_3—I	234	56
CH_3—OH	381	91
Bonds to primary carbons		
CH_3CH_2—H	410	98
CH_3CH_2—F	448	107
CH_3CH_2—Cl	339	81
CH_3CH_2—Br	285	68
CH_3CH_2—I	222	53
CH_3CH_2—OH	381	91
$CH_3CH_2CH_2$—H	410	98
$CH_3CH_2CH_2$—F	448	107
$CH_3CH_2CH_2$—Cl	339	81
$CH_3CH_2CH_2$—Br	285	68
$CH_3CH_2CH_2$—I	222	53
$CH_3CH_2CH_2$—OH	381	91
Bonds to secondary carbons		
$(CH_3)_2CH$—H	397	95
$(CH_3)_2CH$—F	444	106
$(CH_3)_2CH$—Cl	335	80
$(CH_3)_2CH$—Br	285	68
$(CH_3)_2CH$—I	222	53
$(CH_3)_2CH$—OH	381	91
Bonds to tertiary carbons		
$(CH_3)_3C$—H	381	91
$(CH_3)_3C$—F	444	106
$(CH_3)_3C$—Cl	331	79
$(CH_3)_3C$—Br	272	65
$(CH_3)_3C$—I	209	50
$(CH_3)_3C$—OH	381	91
Other C—H bonds		
$PhCH_2$—H (benzylic)	356	85
$CH_2{=}CHCH_2$—H (allylic)	364	87
$CH_2{=}CH$—H (vinyl)	464	111
Ph—H (aromatic)	473	113
C—C bonds		
CH_3—CH_3	368	88
CH_3CH_2—CH_3	356	85
CH_3CH_2—CH_2CH_3	343	82
$(CH_3)_2CH$—CH_3	351	84
$(CH_3)_3C$—CH_3	339	81

hydrogen 1 H 1.0079																	helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ✶ lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	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]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	unumbium 112 Uub [277]		ununquadium 114 Uuq [289]				

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	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]