Organic Structure and Reactivity (CHEM 132-01)

Dr. Fantini

Examination II | ***In-class portion*** | March 25, 2013

Instructions:

1) This exam consists of **7** problems.

2) Work that is not clear and legible will not be graded

3) Method and/or reasoning must be shown. No credit will be given for an answer alone.

4) Give units for all answers and use significant figures.

5) No books or notes are to be used.

6) Do not share calculators

Question	Possible	Score
1	10	
2	8	
3	12	
4	12	
5	20	
6	14	
7	24	
TOTAL	100	
take home	100	
Gr. Total	200	

Name Key Slayter Box 007

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You may CAREFULLY detach the last page of the exam
(solubility rules and periodic table)

Please do not open until instructed

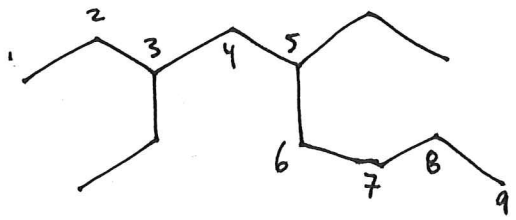
ALLOWED at exam:
Pens, pencils, erasers.
Calculator

NOT ALLOWED at exam:
Cellular telephones and PDA's

10 1. The following name does not follow IUPAC rules: **5-butyl-3-ethylheptane**

(a) Though the name doesn't follow the rules, you can still figure out what the person meant. **Draw the line structure that corresponds to the given name.**

6



(b) Assign the correct IUPAC name to the structure you drew (no stereochemistry).

4

3,5-diethylnonane

8 2. For each of the following reactions, predict whether the entropy change for the system is positive or negative. Give a brief explanation for each answer.

$N_2(g) + 3\,Cl_2(g) \rightarrow 2\,NCl_3(l)$ expect $\Delta S = \ominus$

lost 4 moles of gas

$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$ expect $\Delta S = \oplus$

one mole of gas became 2

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$ expect $\Delta S = \ominus$

two things became one (none are gas)

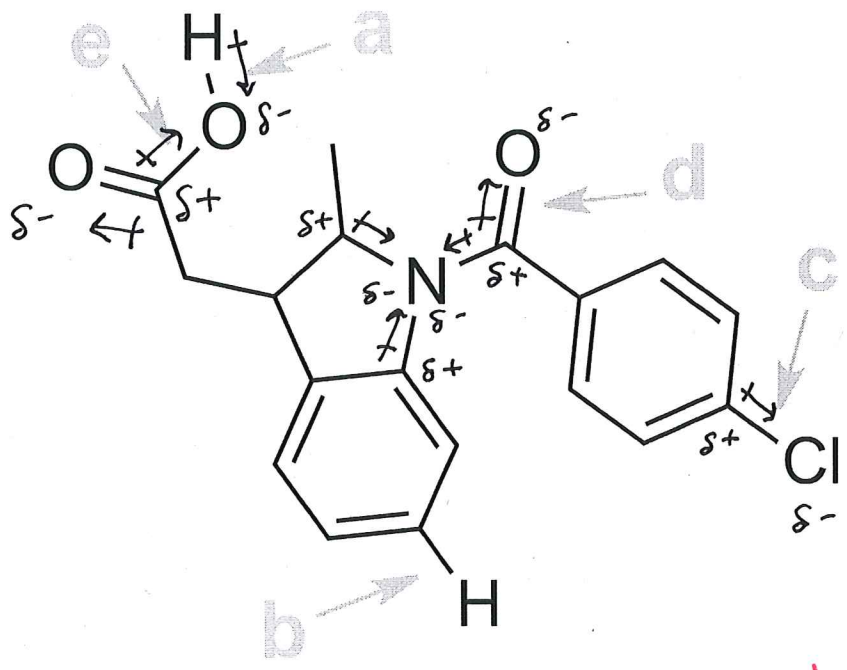
$Br_2(l) \rightarrow Br_2(g)$

expect $\Delta S = \oplus$

gases are more disordered than liquids

123. This is indomethacin, a non-steroidal anti-inflammatory drug.

3 eq



(a) Which bond, **a** or **b**, is shorter, and *why*? explanation is 2 pts of the 3

a is shorter, because both are bonds to H and O is smaller than C

(b) Which bond, **c** or **e**, is shorter? e

(c) Which bond, **d** or **e**, is shorter? d

(c) Label all the δ+ and δ– on the molecule. Draw in all the bond dipoles. ✓

124. Calculate the enthalpy change ($\Delta H°_{rxn}$) for the following reaction using the enthalpy of formation method. A table of selected enthalpies of formation is given at the bottom of the page.

$$P_4O_{10}(s) + 6\ H_2O(l) \rightarrow 4\ H_3PO_4(l)$$

$\Delta H°_{rxn}$ = products − reactants

$\Delta H°_{rxn} = 4(-1280) - [(-2980) + 6(-286)]$

$= -5120 - (-2980 - 1716)$

$= -5120 + 4696$

$\Delta H°_{rxn} = -424$ kJ/mol

compound	$\Delta H°_f$ (kJ/mol)	S° (J/mol·K)
$P_4(g)$	58.9	280
$O_2(g)$	0	205
$H_2(g)$	0	131
$P_4O_{10}(s)$	–2980	229
$C_2H_6(g)$	–84.7	229
$CO_2(g)$	–393.5	214
$H_2O(g)$	–242	189
$H_2O(l)$	–286	70.0
$H_3PO_4(l)$	–1280	110

205. A student named Bart studied the following reaction:

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

Bart obtained some data on the reaction when he carried out the reaction 3 different times, each at a different temperature. The data collected below was obtained once each of the three reactions was at equilibrium. Please answer the questions about the reaction that follow.

favors products at lower T →

favors reactants at higher T →

T (K)	$[N_2]_{eq}$	$[H_2]$	$[NH_3]$	K_{eq}
500	0.115	0.105	0.439	1450
575	0.110	0.249	0.128	9.6
775	0.120	0.140	0.00439	0.0584

2 2 4

1.45×10^3

(a) Please finish Bart's work by completing the three missing entries in the table.

$K = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$ $\quad [H_2] = \sqrt[3]{\dfrac{[NH_3]^2}{[N_2] \cdot K}}$ $\quad [NH_3] = \sqrt{K \cdot [N_2] \cdot [H_2]^3}$

$= \dfrac{(0.439)^2}{(0.115)(0.105)^3}$ $\quad = \sqrt[3]{\dfrac{(0.128)^2}{(0.110)(9.6)}}$ $\quad = \sqrt{(0.0584)(0.12)(0.14)^3}$

=

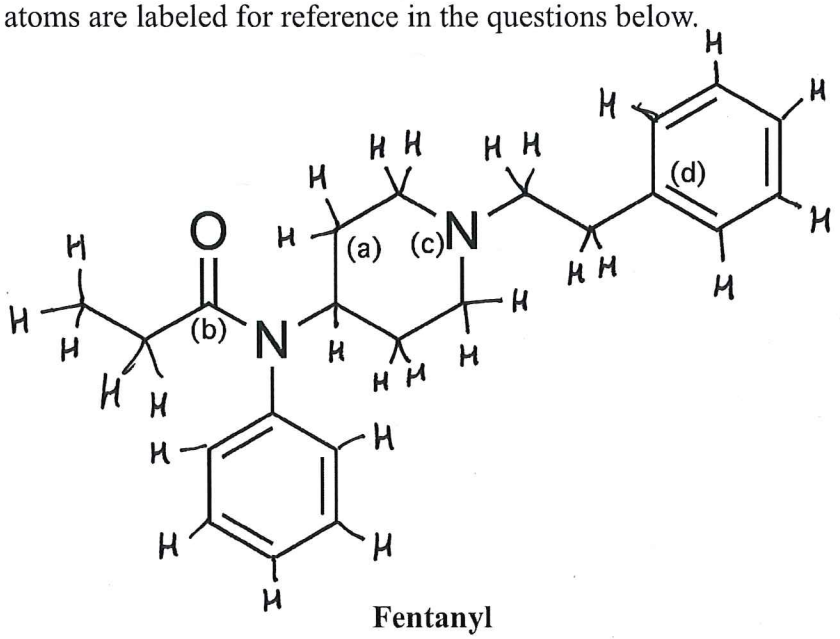
(b) Consider the reaction above. Qualitatively, what would happen if Bart did any of the following things? Circle your answer in each case. (You can tell endothermic or exothermic from the trend in K_{eq} value with temperature in the data above.)

2 eq

Action	Result (circle one per row)		
add hydrogen gas	shift toward reactants	no change	(shift toward products)
remove ammonia	shift toward reactants	no change	(shift toward products)
raise temperature to 1000 K	(shift toward reactants)	no change	shift toward products
add a catalyst for the reaction	shift toward reactants	(no change)	shift toward products
decrease the volume of the container by half	shift toward reactants	no change	(shift toward products)
add solid graphite	shift toward reactants	(no change)	shift toward products

could possibly choose this b/c the graphite takes up space and lowers the available volume.

146. Fentanyl, depicted below as a line drawing, is a narcotic used for surgical anesthesia and pain relief. Some atoms are labeled for reference in the questions below.



Fentanyl

amide nitrogens are sp^2

2 (a) Please neatly draw in all the hydrogens that ***fentanyl*** possesses. ✓

(b) What are the hybrid orbital sets used by the following atoms in bonding:

2 ea

	carbon (a)	carbon (b)	nitrogen (c)	carbon (d)
hybrid orbital set:	sp^3	sp^2	sp^2	sp^2

(c) What is the molecular formula of fentanyl?

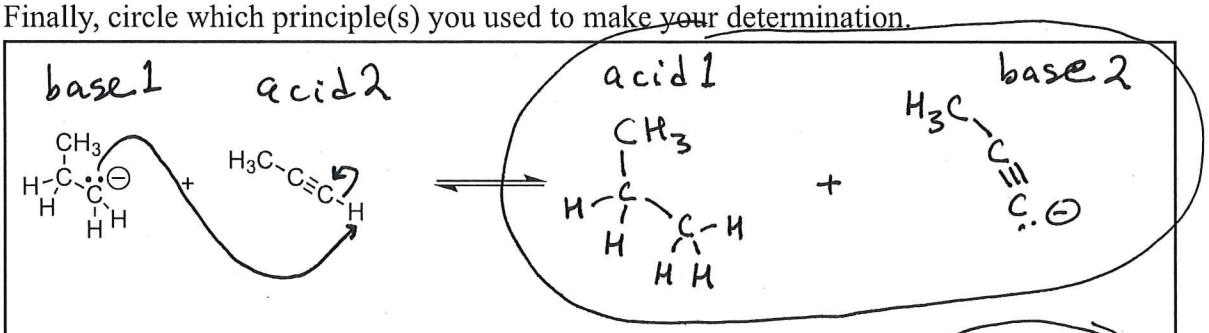
1 $C_{22}H_{28}N_2O$

(d) What is the name for the molecular geometry (not the electron-pair or "overall" geometry) at the following atoms:

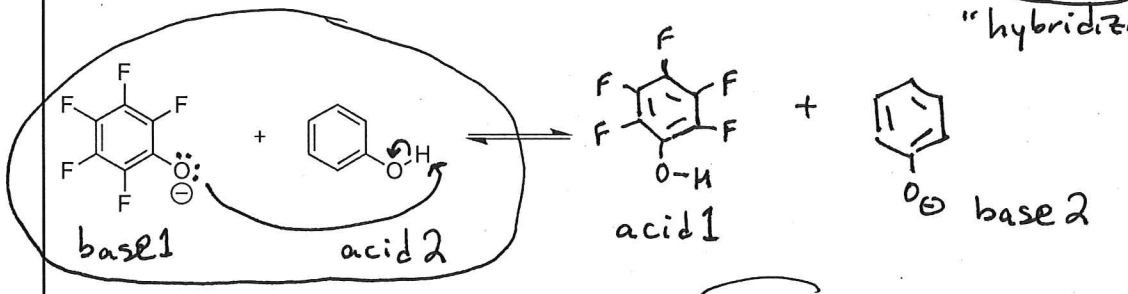
1 ea

	nitrogen (c)	carbon (a)	carbon (d)
molecular geometry name	trigonal pyramidal	tetrahedral	trigonal planar

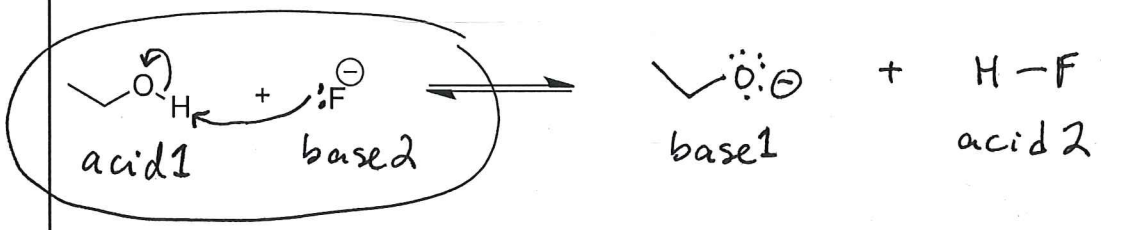
247. Complete the following equations.
2 Clearly identify conjugate acid-base pairs.
2 Circle the side (reactants or products) that dominates at equilibrium.
— Use arrows to show the flow of electrons on the reactant side. (NOT graded)
2 Finally, circle which principle(s) you used to make your determination.



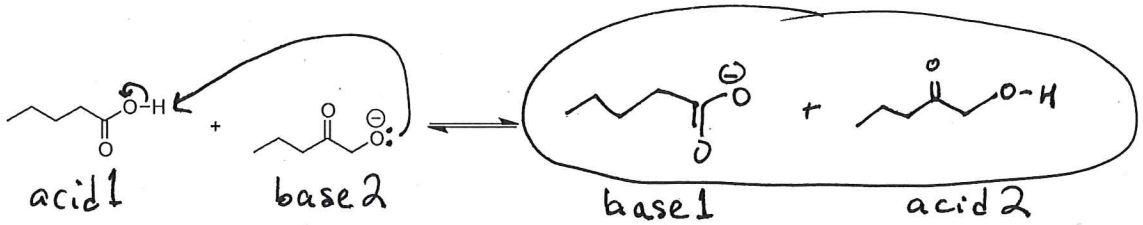
element resonance inductive (orbital) "hybridization"



element resonance (inductive) orbital



(element) resonance inductive orbital



element (resonance) inductive orbital

McQuarrie's Solubility Rules

apply in this order

1. Most alkali metal salts and ammonium salts are soluble.
2. Most nitrates, acetates, and perchlorates are soluble.
3. Most silver, lead, and mercury(I) salts are insoluble.
4. Most chlorides, bromides, and iodides are soluble.
5. Most carbonates, chromates, sulfides, oxides, phosphates, and hydroxides are insoluble, except for hydroxides of Ba^{2+}, Ca^{2+}, and Sr^{2+}, which are slightly soluble.
6. Most sulfates are soluble, except for calcium sulfate and barium sulfate, which are insoluble.

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Uun (269)	111 Uuu (272)	112 Uub (277)						

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)