

Chemistry 130, Midterm Exam 1

Instructor: Bergdahl

Spring 2019

Name: _____

Key

Be prepared to show ID upon request.

****Any use of any electronic devices is prohibited during the test** ****

Be prepared to show ID upon request.

My student I.D. (red I.D.) number is:

Good Luck!!

Part A. 1-25 Questions. Each correct answer is 3 points. (Part 1 max 75 points)

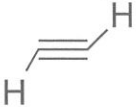
1) What is the electron configuration of negatively charged carbon atom?

- A) $1s^2 2s^2 2p^2$
- ☒ B) $1s^2 2s^2 2p^3$
- C) $1s^2 2s^2 2p^4$
- D) $1s^2 2s^2 2p^5$

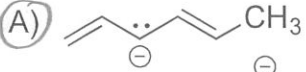
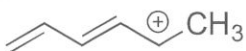
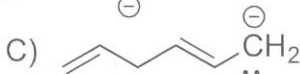
2) Which of the following bonds is ionic?

- A) C—F
- ☒ B) Li—F
- C) H—H
- D) C—H

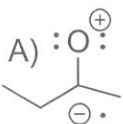
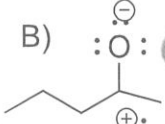
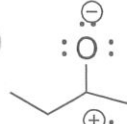
3) Which representation of ethyne (HCCH) is correct.

- ☒ A) $\text{H} \equiv \text{H}$
- B) 
- C) $\text{H} \blacktriangleright \equiv \cdots \text{H}$
- D) $\text{H} = = \text{H}$

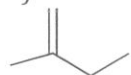
4) Which of the following structures is a valid resonance structure of 

- ☒ A) 
- B) 
- C) 

5) Which of the following contributing resonance structures of butanone is more stable

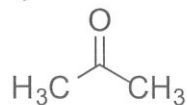
- A) 
- B) 
- ☒ C) 

6) The double bond in butene is formed from the overlap of what orbitals



- ☒ A) $\text{C } sp^2$ orbital overlapping with a $\text{C } sp^2$ orbital; and a $\text{C } p$ orbital overlapping with an $\text{C } p$ orbital.
- B) $\text{C } sp^2$ orbital overlapping with a $\text{C } sp^2$ orbital
- C) a $\text{C } p$ orbital overlapping with an $\text{C } p$ orbital.
- D) a $\text{C } s$ orbital overlapping with an $\text{C } s$ orbital.

7) The Carbon-Hydrogen bonds in acetone are made up of



- A) C sp^2 orbital overlapping with a O sp^2 orbital; and a C P orbital overlapping with an O P orbital.
B) C sp^3 orbital overlapping with a H s orbital
C) a C p orbital overlapping with an H p orbital.
D) a C s orbital overlapping with an C s orbital.

8) Which of the following is the weakest Acid

- A) CH_4 B) H_2O C) NaH D) HI

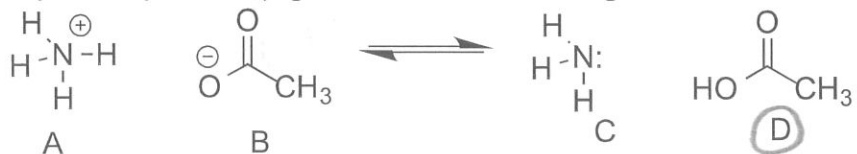
9) Which of the following is the strongest base

- A) NaOH B) CH_3^- C) Cl^- D) HCl

10) The higher the pK_a the _____ the Acid

- A) Weaker B) Stronger C) Lower pH D) higher pH

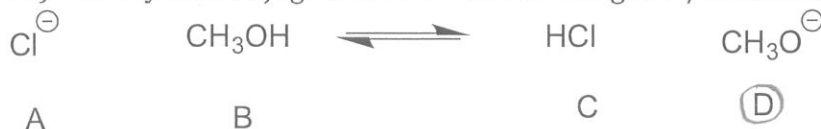
11) Identify the conjugate acid in the following acid Base reaction



12) The reaction in question 11 will have a k_{eq} of

- A) 1
B) Greater than 1
C) Less than 1

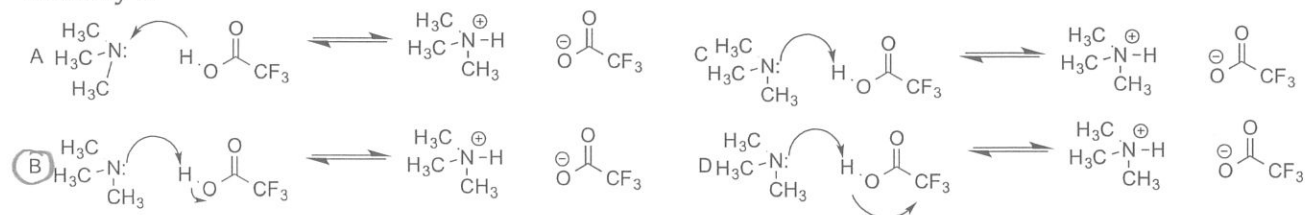
13) Identify the conjugate base in the following acid/base reaction



14) The reaction in question 13 will have a k_{eq} of

- A) 1
B) Greater than 1
C) Less than 1

15) Only one of the mechanisms of the below acid base reaction has the correct arrow pushing. Identify it



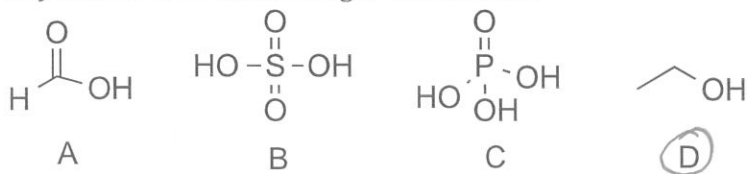
16) Why does HI have a pKa of -9 while HCl as a pKa of -7.

- A) More resonance
- B) I is more electronegative
- C) The inductive effect
- ☒ D) I has a larger atomic radius than Cl.

17) How many times more acidic is HI?

- A) 2 fold
- B) 10 fold
- ☒ C) 100 fold
- D) 1000 fold

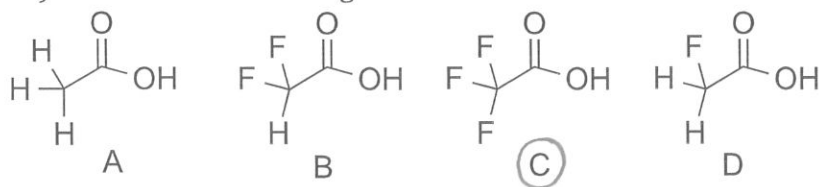
18) Which of the following is least acidic.



19) Your answer is least acidic because

- ☒ A) The conjugate base has no resonance stabilization
- B) The conjugate base is destabilized by the inductive effect
- C) The conjugate base is destabilized because the negative charge is on a more electronegative atom.
- D) The conjugate base is destabilized because there are more possible resonance structures, with one that contributes much more than the others to the hybrid.

20) Which of the following is most acidic.



21) Your answer is more acidic because

- A) The conjugate base is stabilized because there are more resonance structures that contribute substantially. Thus the negative charge is spread out more
- ☒ B) The conjugate base is most stabilized by the inductive effect
- C) The conjugate base is stabilized because the negative charge is on a more electronegative atom.
- D) A&B

22) Which of the following is more acidic.

- A) CH₄ B) CH₃F ☒ C) CF₃OH D) CH₃OH

23) Your answer is more acidic because

- A) The conjugate base is stabilized because there are more resonance structures that contribute substantially. Thus the negative charge is spread out more
- ☒ B) The conjugate base is stabilized by the inductive effect
- ☒ C) The conjugate base is stabilized because the negative charge is on a more electronegative atom.
- D) B&C

24) A Linear alkane with 5 carbons is

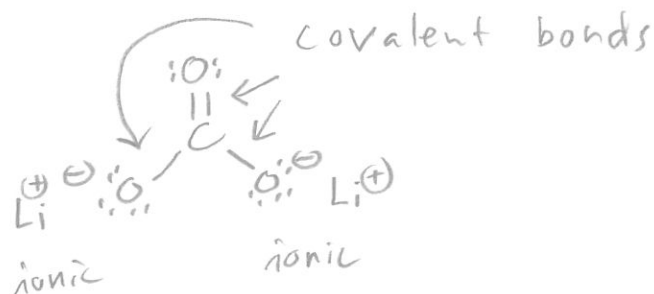
- A) Hexane
- ☒ B) Pentane
- C) Propane
- D) Heptane

25) Constitutional isomers are

- A) Molecules with the same molecular formula and the same connectivity but a different spatial arrangement of atoms in three-dimensional space
- B) Molecules with the same connectivity but a different molecular formula
- ☒ C) Molecules with the same molecular formula but different connectivity of the atoms
- D) Molecules that have identical chemical properties

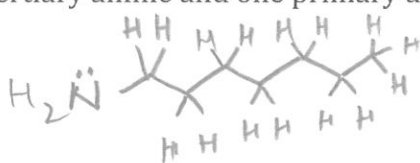
Part B. Short answer questions, 26-32, each problem is worth 5-10 points (total 61 points)

Problem 26. Draw the Lewis structure for Li_2CO_3 . Which bonds are ionic or covalent? (10p)

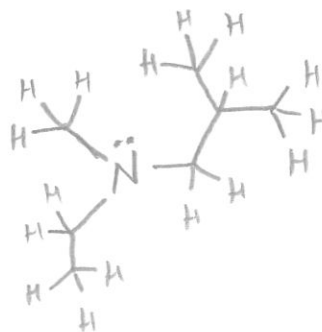


Problem 27. Draw the Lewis structure for TWO compounds with the molecular formula $\text{C}_7\text{H}_{17}\text{N}$, one tertiary amine and one primary amine. (10p)

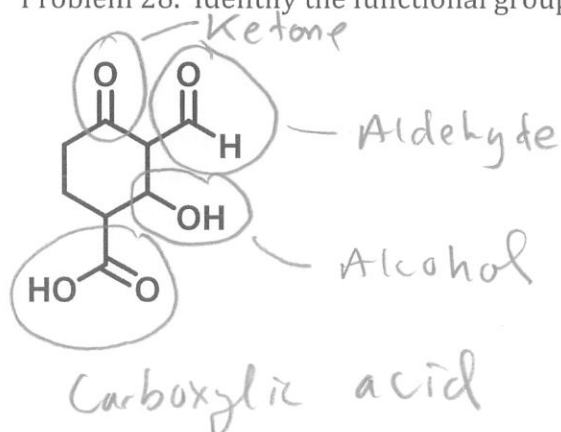
Example
of 1°
amine



Example
of 3°
amine



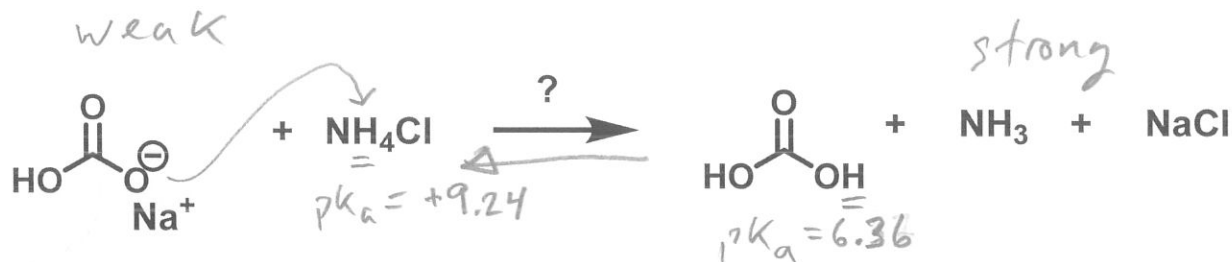
Problem 28. Identify the functional groups in the following molecule: (8p)



Problem 29. Draw the relevant resonance structures for carbonmonoxide, CO. (8p)

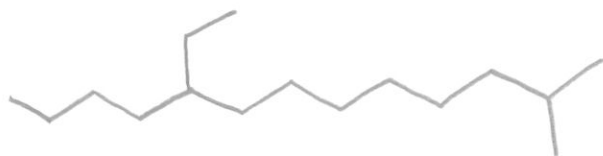


Problem 30. Predict if the following acid-base reaction favorable or unfavorable as indicated.
Justification is (One sentence max) (10p)



The reaction above is unfavorable since there is a stronger acid on the right side, therefore the reaction is favored to the left.

Problem 31. Draw a line-angle structure for the following condensed structural formula. (5p)
 $\text{CH}_3(\text{CH}_2)_3\text{CH}(\text{CH}_2\text{CH}_3)(\text{CH}_2)_6\text{CH}(\text{CH}_3)_2$



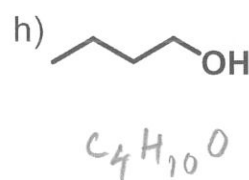
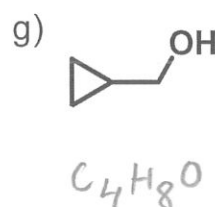
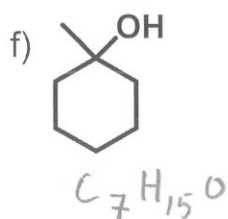
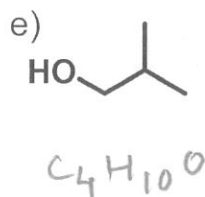
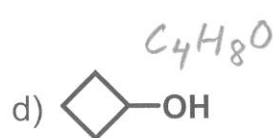
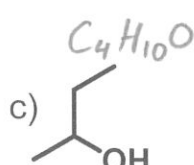
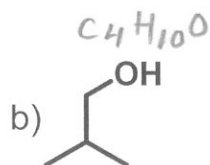
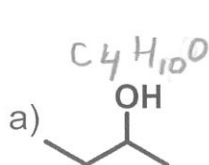
Problem 32. Which of the structural formulas below represent,

15p

A) The same compound 5p

B) Different compounds that are constitutional isomers 5p

C) Different compounds that are NOT constitutional isomers 5p



A) a) and c) are the same (identical)
b) and e) are the same (identical)

B) d) and g) are constitutional isomers

a) and b) are —||—
(c) and e) are —||—)

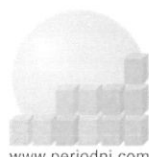
C) f) is different to all

d) and g) are different to all

PERIODIC TABLE OF THE ELEMENTS

GROUP	1	2											13	14	15	16	17	18
PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 1.008 HYDROGEN																	He 4.0026 HELIUM
2	Li 6.94 LITHIUM	Be 9.0122 BERYLLIUM											B 10.81 BORON	C 12.011 CARBON	N 14.007 NITROGEN	O 15.999 OXYGEN	F 18.998 FLUORINE	Ne 20.180 NEON
3	Na 22.990 SODIUM	Mg 24.305 MAGNESIUM											Al 26.982 ALUMINUM	Si 28.085 SILICON	P 30.974 PHOSPHORUS	S 32.06 SULPHUR	Cl 35.45 CHLORINE	Ar 39.948 ARGON
4	K 39.098 POTASSIUM	Ca 40.078 CALCIUM	Sc 44.956 SCANDIUM	Ti 47.867 TITANIUM	V 50.942 VANADIUM	Cr 51.996 CHROMIUM	Mn 54.938 MANGANESE	Fe 55.845 IRON	Co 58.933 COBALT	Ni 58.693 NICKEL	Cu 63.546 COPPER	Zn 65.38 ZINC	Ga 69.723 GALLIUM	Ge 72.64 GERMANIUM	As 74.922 ARSENIC	Se 78.971 SELENIUM	Br 79.904 BROMINE	Kr 83.798 KRYPTON
5	Rb 85.468 RUBIDIUM	Sr 87.62 STRONTIUM	Y 88.906 YTTORIUM	Zr 91.224 ZIRCONIUM	Nb 92.906 NIObIUM	Mo 95.95 MOLYBDENUM	Tc (98) TECHNETIUM	Ru 101.07 RUTHENIUM	Rh 102.91 RHODIUM	Pd 106.42 PALLADIUM	Ag 107.87 SILVER	Cd 112.41 CADMIUM	In 114.82 INDIUM	Sn 118.71 TIM	Sb 121.76 ANTIMONY	Te 127.60 TELLURIUM	I 126.90 IODINE	Xe 131.29 XENON
6	Cs 132.91 CAESIUM	Ba 137.33 BARIUM	La-Lu 57-71 Lanthanide	Hf 178.49 HAFNIUM	Ta 180.95 TANTALUM	W 183.84 TUNGSTEN	Re 186.21 RHENIUM	Os 190.23 OSMIUM	Ir 192.22 IRIDIUM	Pt 195.08 PLATINUM	Au 196.97 GOLD	Hg 200.59 MERCURY	Tl 204.38 THALLIUM	Pb 207.2 LEAD	Bi 208.98 BISMUTH	Po (209) POLONIUM	At (210) ASTATINE	Rn (222) RADON
7	Fr (223) FRANCIUM	Ra (226) RADIUM	Ac-Lr 89-103 Actinide	Rf (261) RUTHERFORDIUM	Db (268) DUBNIUM	Sg (271) SEABORGIUM	Bh (272) BOHRNIUM	Hs (277) HASSIUM	Mt (276) MEITNERIUM	Ds (281) DARSTADTIUM	Rg (286) ROBERTSIUM	Cn (285) COPIERNICIUM	Uut (287) UNUNTRIUM	Fl (287) FLEROVIUM	Uup (287) UNUNPENTIUM	Lv (291) LIVERMORIUM	Uus (294) UNUNSEPTIUM	Uuo (294) UNUNOCTIUM

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(1) Pure Appl. Chem., 88, 265-291 (2016)

LANTHANIDE

57 138.91 La LANTHANUM	58 140.12 Ce CERIUM	59 140.91 Pr PRASEODYMIUM	60 144.24 Nd NEODYMIUM	61 (145) Pm PROMETHIUM	62 150.36 Sm SAMARIUM	63 151.96 Eu EUROPIUM	64 157.25 Gd GADOLINIUM	65 158.93 Tb TERBIUM	66 162.50 Dy DYSPROSIUM	67 164.93 Ho HOLMIUM	68 167.26 Er ERBIUM	69 168.93 Tm THULIUM	70 173.05 Yb YTTERIUM	71 174.97 Lu LUTETIUM
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ACTINIDE

89 (227) Ac ACTINIUM	90 232.04 Th THORIUM	91 231.04 Pa PROTACTINIUM	92 238.03 U URANIUM	93 (237) Np NEPTUNIUM	94 (244) Pu PLUTONIUM	95 (243) Am AMERICIUM	96 (247) Cm CURIUM	97 (247) Bk BERKELIUM	98 (251) Cf CALIFORNIUM	99 (252) Es EINSTEINIUM	100 (257) Fm FERMIUM	101 (258) Md MENDELEVIUM	102 (259) No NOBELIUM	103 (262) Lr LAWRENCIUM
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TABLE 1.4 Electronegativity Values and Trends for Some Atoms (Pauling Scale)

Electronegativity increases →

↑ Electronegativity increases

1A	2A											3A	4A	5A	6A	7A		
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0		
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0		
K 0.8	Ca 1.0	3B	4B	5B	6B	7B	8B					1B	2B	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5		
Cs 0.7	Ba 0.9	La 1.1	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2		

<1.0
 1.5 – 1.9
 2.5 – 2.9

1.0 – 1.4
 2.0 – 2.4
 3.0 – 4.0

TABLE 2.2 pK_a Values for Some Organic and Inorganic Acids

	Acid	Formula	pK_a	Conjugate Base	
Weaker acid ↓	ethane	CH_3CH_3	51	$CH_3CH_2^-$	Stronger base ↑
	ammonia	NH_3	38	NH_2^-	
	ethanol	CH_3CH_2OH	15.9	$CH_3CH_2O^-$	
	water	H_2O	15.7	HO^-	
	methylammonium ion	$CH_3NH_3^+$	10.64	CH_3NH_2	
	bicarbonate ion	HCO_3^-	10.33	CO_3^{2-}	
	phenol	C_6H_5OH	9.95	$C_6H_5O^-$	
	ammonium ion	NH_4^+	9.24	NH_3	
	hydrogen cyanide	HCN	9.21	CN^-	
	carbonic acid	H_2CO_3	6.36	HCO_3^-	
Stronger acid ↓	acetic acid	CH_3COOH	4.76	CH_3COO^-	Weaker base ↑
	benzoic acid	C_6H_5COOH	4.19	$C_6H_5COO^-$	
	phosphoric acid	H_3PO_4	2.1	$H_2PO_4^-$	
	hydronium ion	H_3O^+	-1.74	H_2O	
	sulfuric acid	H_2SO_4	-5.2	HSO_4^-	
	hydrogen chloride	HCl	-7	Cl^-	
	hydrogen bromide	HBr	-8	Br^-	
	hydrogen iodide	HI	-9	I^-	

the weaker the acid, the stronger is its conjugate base

the stronger the acid, the weaker is its conjugate base

Grading:

Part A _____/75 points

Part B _____/⁶⁶~~61~~ points

Total _____/¹⁴¹~~136~~ points

Adjusted _____/150 points