

Chemistry 130, Final Exam

Instructor: Bergdahl

Spring 2019

Name: _____

Be prepared to show ID upon request.

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

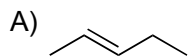
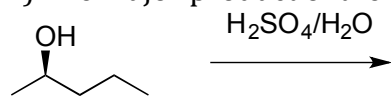
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My student I.D. (red I.D.) number is:

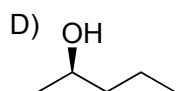
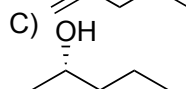
Good Luck!!

Part A. 1-50 Questions. Each correct is 3 points. (Part 1 max 150 points)

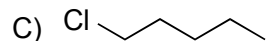
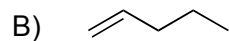
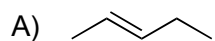
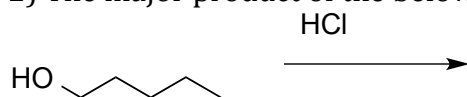
1) The major product of the below reaction will be



B) 

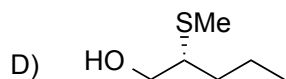
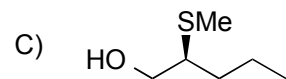
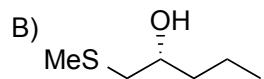
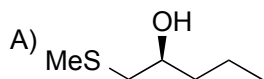
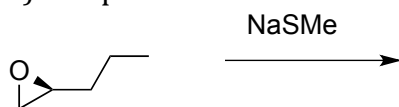


2) The major product of the below reaction will be



D) no reaction

3) The product of the reaction below is



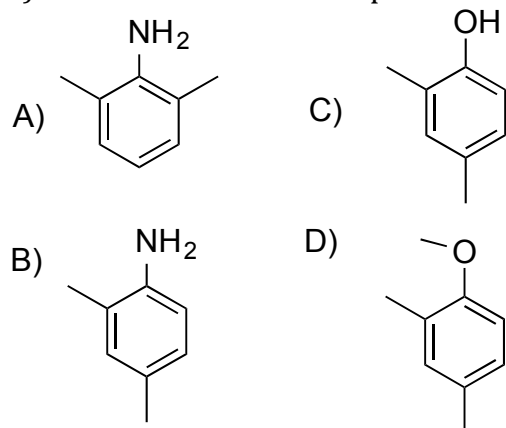
4) Epoxides are good electrophiles because

- A) RO⁻ is a good leaving group
- B) Epoxide opening after nucleophilic attack relieves a lot of ring strain
- C) They are not good electrophiles.
- D) There are no sterics because of the small 3 membered ring

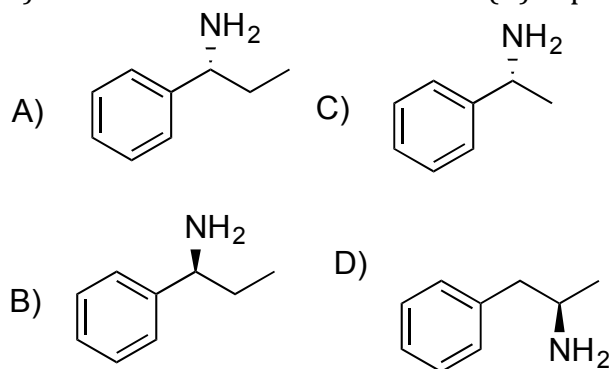
5) An alkaloid is

- A) An opioid from nature
- B) A complex molecule found in nature with a bunch of heteroatoms in it
- C) A basic molecule found in nature with nitrogen atoms in the structure
- D) A neutral molecule found in nature with oxygen atoms in the structure

6) Which of the below compounds is 2,4-dimethylaniline



7) Which of the molecules below is (R)-1-phenyl-1-propanamine



8) Which compound will have the highest boiling point.

- A) C₂H₆ B) CH₃NH₂ C) CH₃OH D) CH₃OCH₃

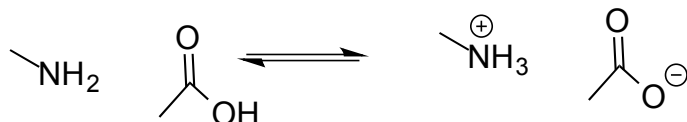
9) Which compound is the better base.

- A) C₂H₆ B) CH₃NH₂ C) CH₃OH D) CH₃OCH₃

10) Why are alcohols worse bases than amines?

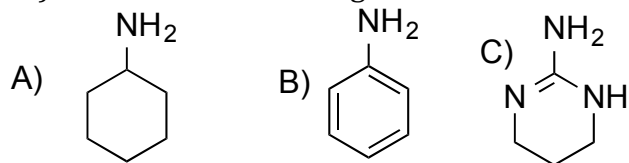
- A) Because nitrogen is more electronegative, the lone pair of electrons is more easily shared
- B) Because nitrogen is less electronegative, the positive charge in the conjugate acid is more stable with amines
- C) Actually, alcohols are always stronger bases than amines.

11) The K_{eq} for the below reaction is



- A) 1
- B) greater than 1
- C) less than 1

12) Which of the following amines is the strongest base?



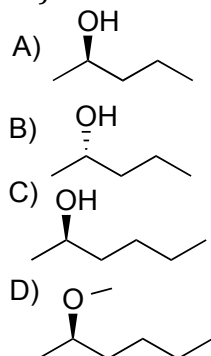
13) Why?

- A) Resonance stabilizes the lone pair of electrons on the basic nitrogen
- B) Electronegativity
- C) Resonance destabilizes the lone pair of electrons on the basic nitrogen
- D) The inductive effect

14) The oxygen in a hydroxyl group is ____ hybridized and has bond angles of ____

- A) sp, 180
- B) sp^3 , 120
- C) sp^2 , 120
- D) sp^3 , 109.5

15) Which molecule below is *R*-2-pentanol



16) What is the electron configuration of a neutral Nitrogen atom?

A) $1s^2 2s^2 2p^5$

B) $1s^2 2s^2 2p^3$

C) $1s^2 2s^2 2p^4$

D) $1s^2 2s^2 2p^2$

17) Molecule _____ is enol tautomer and the K_{eq} of this reaction is _____



A

B

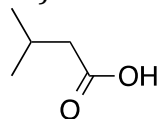
A) A, greater than 1

B) B, greater than 1

C) A, less than 1

D) B, less than 1

18) The name of the following molecule is



A) 2-methyl butanoic acid

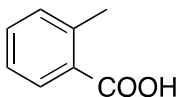
B) 3-methyl butanoic acid

C) 2-methyl propanoic acid

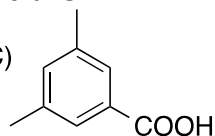
D) isovaleric acid

19) 3-methyl benzoic acid is

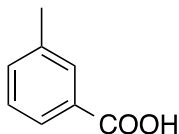
A)



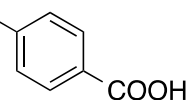
C)



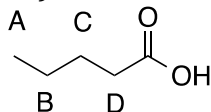
B)



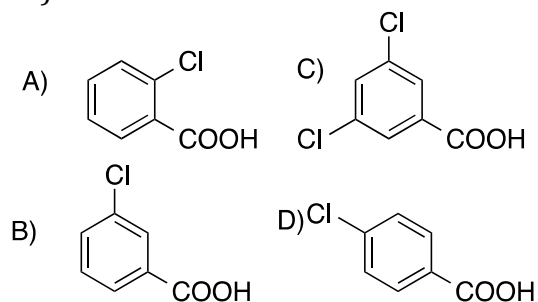
D)



20) Which carbon refers to the alpha carbon?



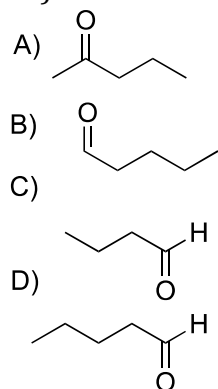
21) Which Acid is the most acidic



22) The carbon in a carbonyl group is ____ hybridized and has a partial ____

- A) sp , positive charge
- B) sp^2 , positive charge
- C) sp^2 , negative charge
- D) sp^3 , positive charge

23) which molecule below is pentanal



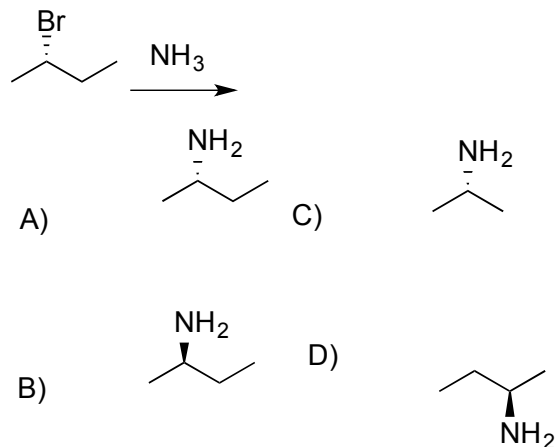
24) aldehydes are generally _____ polar than ketones

- A) Less
- B) More
- C) similarly

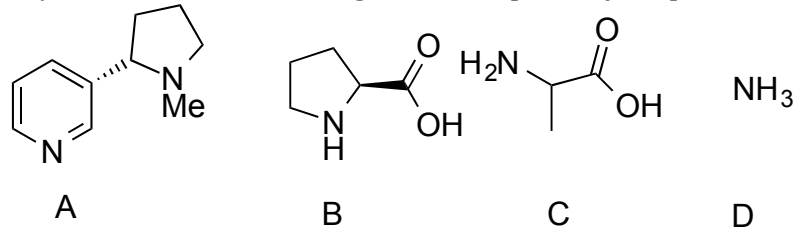
25) Alcohols have _____ boiling points than comparably sized aldehydes/ketones

- A) Higher
- B) Lower

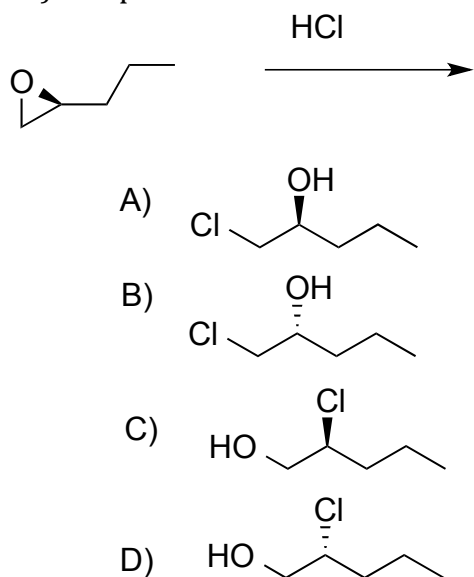
26) Predict the major product from the below reaction



27) Which of the following amines is primary aliphatic



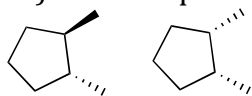
28) The product of the reaction below is



29) alcohols are _____ acidic than thiols

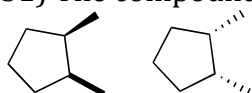
- A) more
B) Less

30) The compounds below are



- A) Constitutional Isomers
- B) Enantiomers
- C) Diastereomers
- D) Geometric Isomers
- E) the same molecule

31) The compounds below are

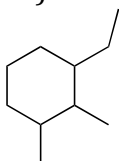


- A) Constitutional Isomers
- B) Enantiomers
- C) Diastereomers
- D) Geometric Isomers
- E) the same molecule

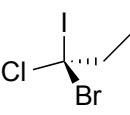
32) Enantiomers are

- A) Superposable mirror images
- B) Non-superposable mirror images
- C) Molecules that have the same connectivity but a different orientation of atoms in 3-dimensional space
- D) Molecules that have the same molecular formula but a different connectivity.

33) How many possible stereoisomers does the compound below have?

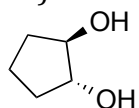


- A) 2
- B) 6
- C) 8
- D) 12

34)  Is in the ____ configuration

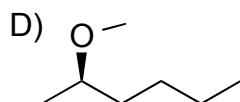
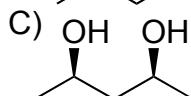
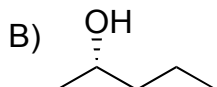
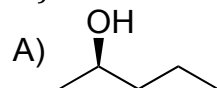
- A) S
- B) R

35) The stereocenters in the below molecule are in the _____ configuration



- A) S,S
- B) R,R
- C) R,S
- D) S,R
- E) none of the above because molecule is not chiral

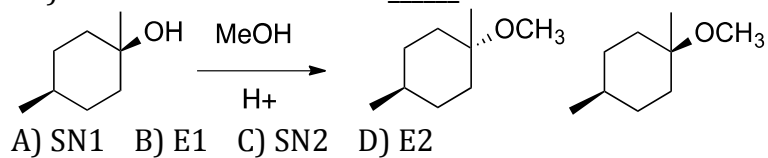
36) Which of the compounds below will have the lowest boiling point



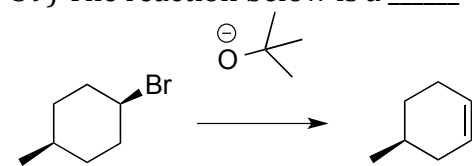
37) How many steps are there in the mechanism of a SN1 nucleophilic displacement reaction?

- A) 1
- B) 2
- C) 3
- D) 4

38) The reaction below is a _____

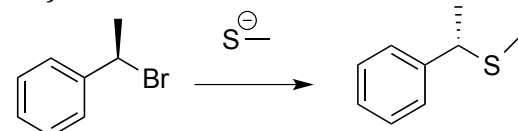


39) The reaction below is a _____



A) SN1 B) E1 C) SN2 D) E2

40) The reaction below is a _____

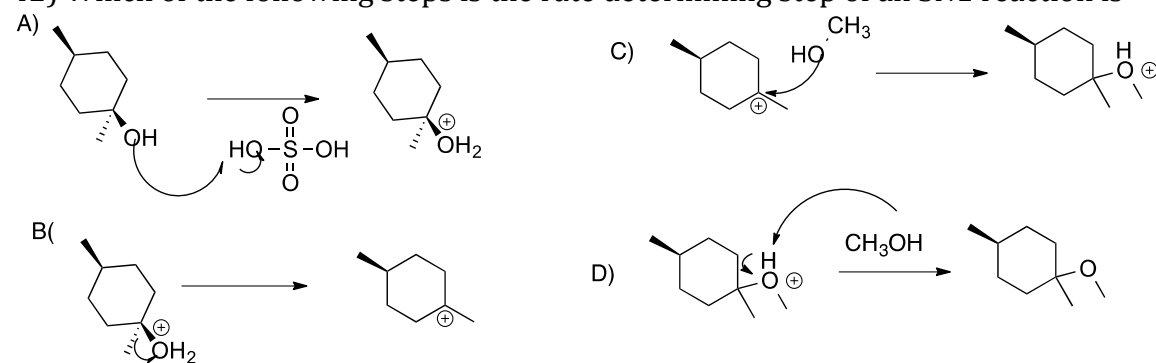


A) SN1 B) E1 C) SN2 D) E2

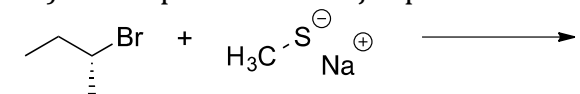
41) Which of the below anions is the best leaving group

A) I^- B) Br^- C) Cl^- D) F^-

42) Which of the following steps is the rate determining step of an SN1 reaction is



43) Please predict the major product form the below reaction



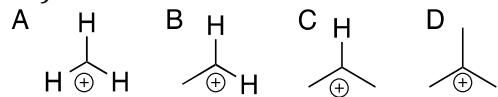
A)

C)

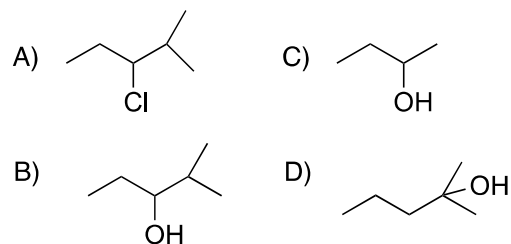
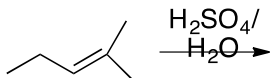
B)

D)

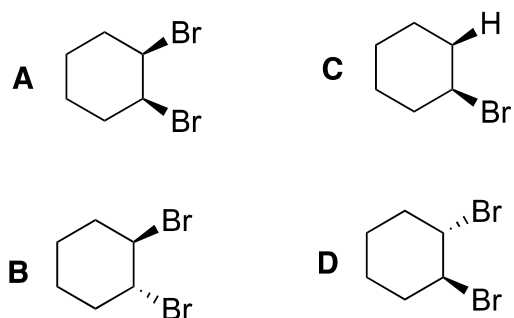
44) The most stable carbocation below is



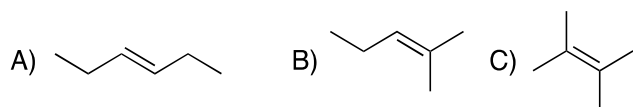
45) Predict the product of the below reaction



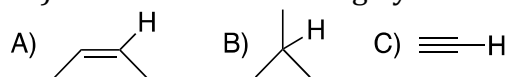
46) Predict the product of the below reaction



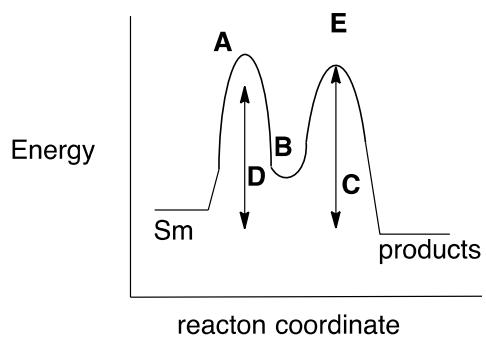
47) Which of the below alkenes will have the highest boiling point?



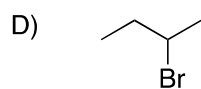
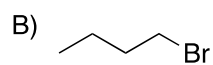
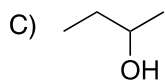
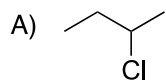
48) Which of the following hydrocarbons is least acidic?



49) The Intermediate in the reaction profile below corresponds to _____
 Sm=Starting materials

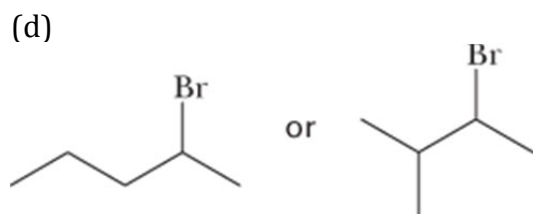
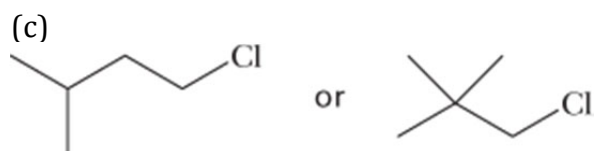
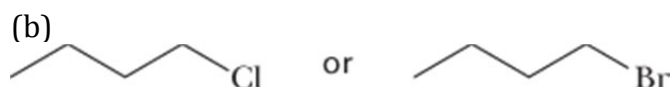
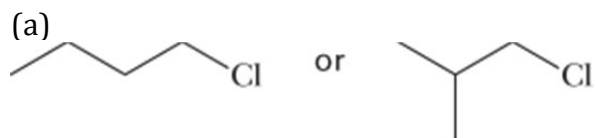


50) Predict the product of the below reaction
 HBr

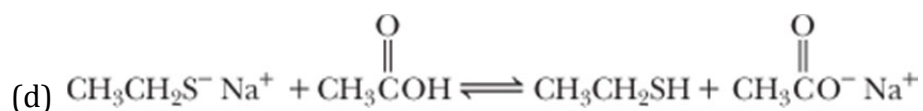
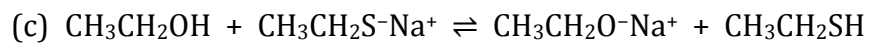
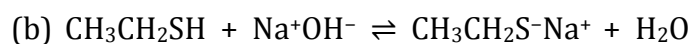
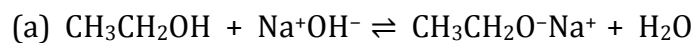


Part B. Short answer questions, 51-60, each problem is worth 8-15 points (total 100 points)

Problem 51. Select the member of each pair that shows the greater rate of S_N2 reaction with KI in acetone. (8p)



Problem 52. Predict the position of equilibrium for each acid-base reaction; that is, does each lie considerably to the **left**, does each lie considerably to the **right**, or are the concentrations **evenly** balanced? (Use letters **L**, **R** or **E** above the equilibrium arrows for a-d) (8p)



Problem 53. Draw a structural formula for each compound (given are IUPAC names). (9p)

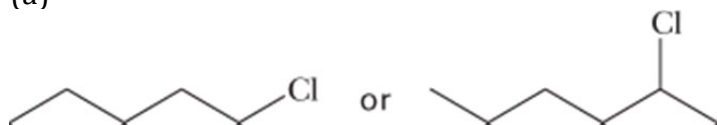
(a) 3-Aminopropene

(b) (R)-2-pentanol

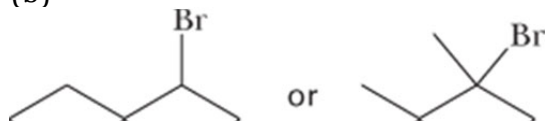
(c) meso-1,2-Dibromocyclopentane

Problem 54. Select the member of each pair that undergoes nucleophilic substitution in aqueous ethanol more rapidly. (9p)

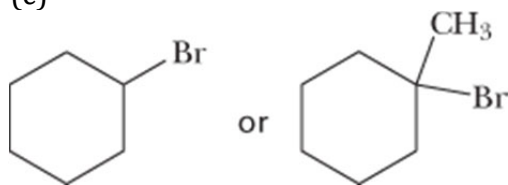
(a)



(b)

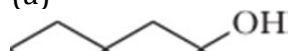


(c)

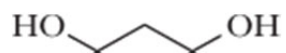


Problem 55. Provide an IUPAC or common name for the molecules below (15p)

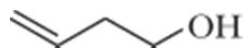
(a)



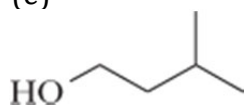
(b)



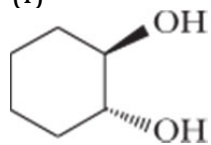
(c)



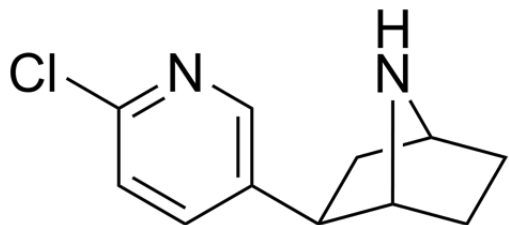
(e)



(f)



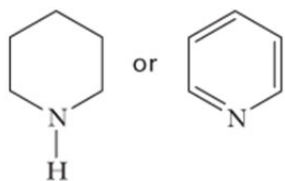
Problem 56. Epibatidine (below), a colorless oil isolated from the skin of the Ecuadorian poison frog *Epipedobates tricolor*, has several times the analgesic potency of morphine. It is the first nonopioid (nonmorphine-like in structure) analgesic ever isolated from a natural source. (8p)



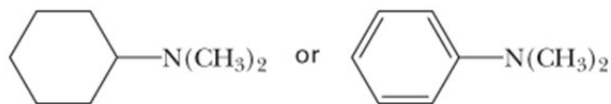
- (a) Which of the two nitrogen atoms of epibatidine is the more basic?
- (b) Mark all stereocenters in this molecule.

Problem 57. From each pair of compounds, select the stronger base. (12p)

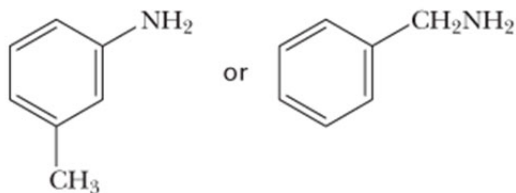
(a)



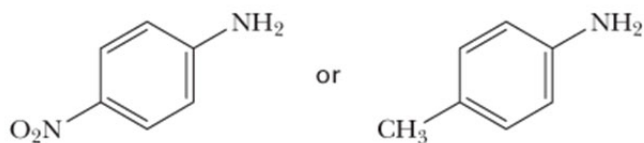
(b)



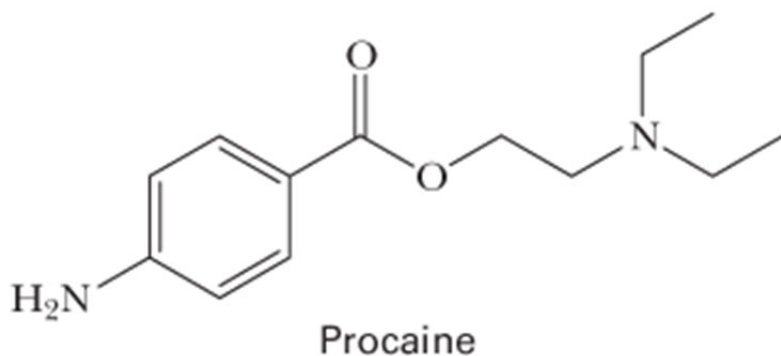
(c)



(d)

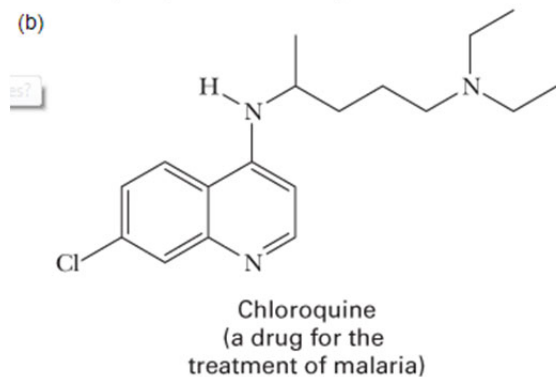
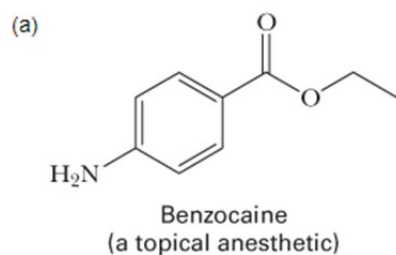


Problem 58. Procaine was one of the first local anesthetics for infiltration and regional anesthesia. The hydrochloride salt of procaine is marketed as Novocaine®. (6p)



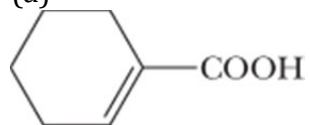
- (a) Which nitrogen atom of procaine is the stronger base?
- (b) Draw the formula of the salt formed by treating procaine with one mole of HCl.
- (c) Is procaine chiral? Would a solution of Novocaine® in water be optically active or optically inactive?

Problem 59. Classify each amino group as primary, secondary, or tertiary and as aliphatic or aromatic. (10p)

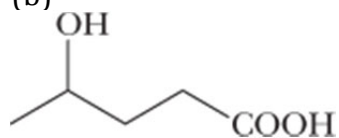


Problem 60. Write the IUPAC name for each compound below. (15p)

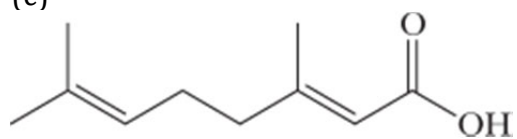
(a)



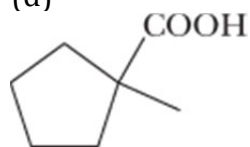
(b)



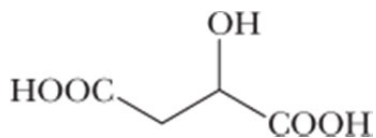
(c)



(d)



(e)



PERIODIC TABLE OF THE ELEMENTS

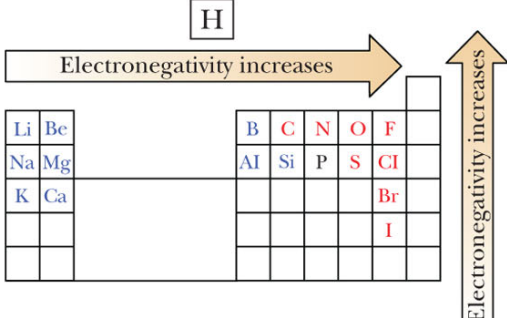
PERIOD		GROUP																												18 VIIA							
		1	IA		2	IIA												13	14	15	16	17	VIIA	18	VIIIA												
1		1	1.008																	2	4.0026																
			H																		He																
			HYDROGEN																		HELIUM																
2		3	6.94	4	9.0122														5	10.81	6	12.011	7	14.007	8	15.999	9	18.998	10	20.180							
			Li		Be															B		C		N		O		F		Ne							
			LITHIUM		BERYLLIUM															BORON		CARBON		NITROGEN		OXYGEN		FLUORINE		NEON							
3		11	22.990	12	24.305														13	26.982	14	28.085	15	30.974	16	32.06	17	35.45	18	39.948							
			Na		Mg															Al		Si		P		S		Cl		Ar							
			SODIUM		MAGNESIUM															ALUMINIUM		SILICON		PHOSPHORUS		SULPHUR		CHLORINE		ARGON							
4		19	39.098	20	40.078	21	44.956	22	47.867	23	50.942	24	51.996	25	54.938	26	55.845	27	58.933	28	58.693	29	63.546	30	65.38	31	69.723	32	72.64	33	74.922	34	78.971	35	79.904	36	83.798
			K		Ca		Sc		Ti		V		Cr		Mn		Fe		Co		Ni		Cu		Zn		Ga		Ge		As		Se		Br		Kr
			POTASSIUM		CALCIUM		SCANDIUM		TITANIUM		VANADIUM		CHROMIUM		MANGANESE		IRON		COBALT		NICKEL		COPPER		ZINC		GALLIUM		GERMANIUM		ARSENIC		SELENIUM		BROMINE		KRYPTON
5		37	85.468	38	87.62	39	88.906	40	91.224	41	92.906	42	95.95	43	(98)	44	101.07	45	102.91	46	106.42	47	107.87	48	112.41	49	114.82	50	118.71	51	121.76	52	127.60	53	126.90	54	131.29
			Rb		Sr		Y		Zr		Nb		Mo		Tc		Ru		Rh		Pd		Ag		Cd		In		Sn		Sb		Te		I		Xe
			RUBIDIUM		STRONTIUM		YTTORIUM		ZIRCONIUM		NIOBIUM		MOLYBDENUM		TECHNETIUM		RUTHENIUM		RHODIUM		PALLADIUM		SILVER		CADMIUM		INDIUM		TIN		ANTIMONY		TELLURIUM		IODINE		XENON
6		55	132.91	56	137.33	57-71		72	178.49	73	180.95	74	183.84	75	186.21	76	190.23	77	192.22	78	195.08	79	196.97	80	200.59	81	204.38	82	207.2	83	208.98	84	(209)	85	(210)	86	(222)
			Cs		Ba		La-Lu		Hf		Ta		W		Re		Os		Ir		Pt		Au		Hg		Tl		Pb		Bi		Po		At		Rn
			CAESIUM		BARIUM		Lanthanide		HAFNIUM		TANTALUM		TUNGSTEN		RHENIUM		OSMIUM		IRIDIUM		PLATINUM		GOLD		MERCURY		THALLIUM		LEAD		BISMUTH		POLONIUM		ASTATINE		RADON
7		87	(223)	88	(226)	89-103		104	(267)	105	(268)	106	(271)	107	(272)	108	(277)	109	(276)	110	(281)	111	(280)	112	(285)	113	(...)	114	(287)	115	(...)	116	(291)	117	(...)	118	(...)
			Fr		Ra		Ac-Lr		Rf		Db		Sg		Bh		Hs		Mt		Ds		Rg		Cn		Uut		Uu		Uup		Uuq		Uus		Uuo
			FRANCIUM		RADIUM		Actinide		RUTHERFORDIUM		DUBNIUM		SEABORGIUM		BOHRILIUM		HASSIUM		MEITNERIUM		DARMSTADTIUM		ROENTGENIUM		COPERNICIUM		UNUNTRIUM		FLEROVIUM		UNUNPENTIUM		LIVERMORIUM		UNUNSEPTIUM		UNUNOCTIUM

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

LANTHANIDE														57	138.91	58	140.12	59	140.91	60	144.24	61	(145)	62	150.36	63	151.96	64	157.25	65	158.93	66	162.50	67	164.93	68	167.26	69	168.93	70	173.05	71	174.97
															La		Ce		Pr		Nd		Pm		Sm		Eu		Gd		Tb		Dy		Ho		Er		Tm		Yb		Lu
															LANTHANUM		CERIUM		PRASEODYMIUM		NEODYMIUM		PROMETHIUM		SAMARIUM		EUROPIUM		GADOLINIUM		TERBIUM		DYSPROSIUM		HOLMIUM		ERBIUM		THULIUM		YTTERIUM		LUTETIUM
ACTINIDE														89	(227)	90	232.04	91	231.04	92	238.03	93	(237)	94	(244)	95	(243)	96	(247)	97	(247)	98	(251)	99	(252)	100	(257)	101	(258)	102	(259)	103	(262)
															Ac		Th		Pa		U		Np		Pu		Am		Cm		Bk		Cf		Es		Fm		Md		No		Lr
															ACTINIUM		THORIUM		PROTACTINIUM		URANIUM		NEPTUNIUM		PLUTONIUM		AMERICIUM		CURIUM		BERKELIUM		CALIFORNIUM		EINSTEINIUM		FERMIUM		MENDELEVIUM		NOBELIUM		LAWRENCIUM

TABLE 1.4 Electronegativity Values and Trends for Some Atoms (Pauling Scale)


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	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	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	
<div> <div>the weaker the acid, the stronger is its conjugate base</div> <div> <div>Weaker acid</div> <div>↓</div> <div>Stronger acid</div> </div> </div>	ethane	CH_3CH_3	51	$CH_3CH_2^-$	<div> <div>Stronger base</div> <div>↑</div> <div>Weaker base</div> </div>
	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^-	
	acetic acid	CH_3COOH	4.76	CH_3COO^-	
	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 _____/150 points**

Part B _____/100 points

Total _____/250 points