

Chemistry 130, Midterm Exam 2

Instructor: Bergdahl

Spring 2019

Name: _____

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)

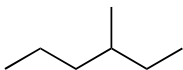
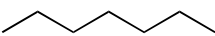
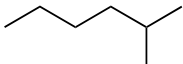
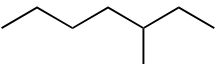
1) Constitutional isomers are

- 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

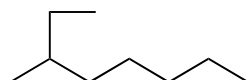
2) Which alkane molecular formula has the least number of constitutional isomers

- A) C_2H_6
- B) C_4H_{10}
- C) $C_{10}H_{22}$
- D) C_6H_{14}

3) Which of the following compounds is 3-methylheptane

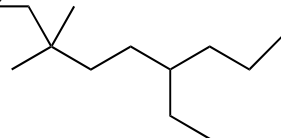
- A)  C) 
- B)  D) 

4) please provide the IUPAC name of the molecule shown below



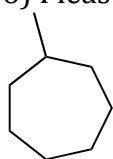
- A) 5-Methylheptane
- B) 3-Methyloctane
- C) 2-ethylheptane
- D) 2-methylhexane

5) Provide the IUPAC name of the molecule shown below



- A) 2,2-dimethyl-5-ethyloctane
- B) 3,3-dimethyl-6-ethylnonane
- C) 6-ethyl-3,3-dimethylnonane
- D) 2,2-dimethyl-5-propylnonane

6) Please provide the IUPAC name of the molecule shown below

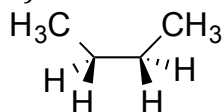


- A) methylcyclohexane
- B) methylhexane
- C) methylcycloheptane
- D) cyclohexylmethyl

7) In the highest energy conformation of butane the C-C bonds are in the _____ conformation. Butane:

- A) Staggered
- B) eclipsed
- C) Gauche

8) In the below representation of butane the 2,3 C-C bond is in the _____ conformation.

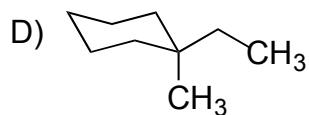
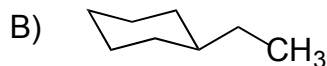
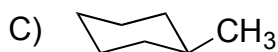
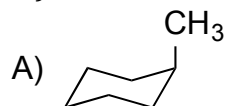


- A) Staggered
- B) eclipsed
- C) Gauche

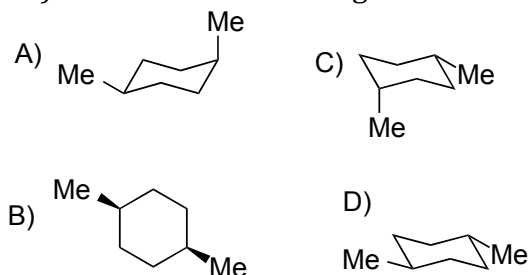
9) The most stable cyclohexane conformation is called the _____ conformation

- A) Boat
- B) Twist Boat
- C) Half Chair
- D) Chair

10) Which of the following is the lowest energy conformation of methylcyclohexane

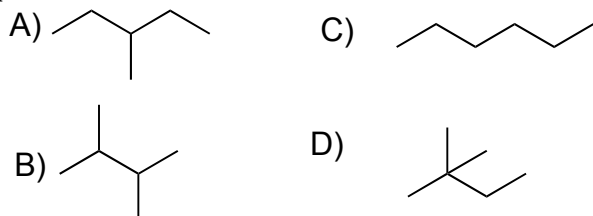


11) Which of the following structures is trans-1,4 dimethylcyclohexane

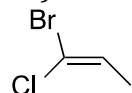


E) A, B&C

12) Which of the following 6 carbon constitutional isomers will have the lowest boiling point



13) According to IUPAC rules the below alkene is

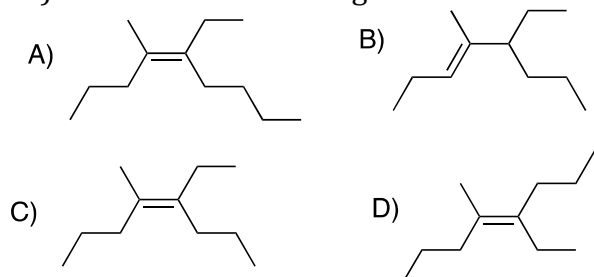


- A) Cis
- B) Trans
- C) E
- D) Z
- E) Neither

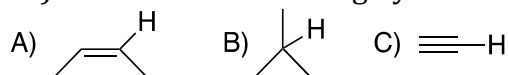
14) The name of the alkene from 13 (above) is

- A) E-1-bromo-1-chloro-1-propene
- B) Z-1-bromo-1-chloro-1-propene
- A) E-1-chloro-1-bromo-1-propene
- D) E-2-chloro-3-butene

15) Which of the following molecules is E-5-ethyl-4-methyl-3-octene



16) Which of the following hydrocarbons is least acidic?



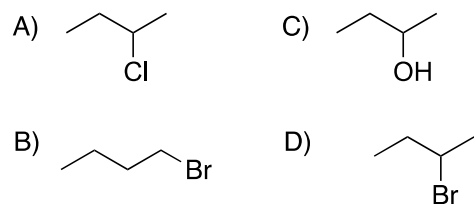
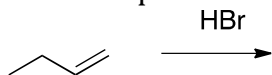
17) Why?

A) The conjugate base is less stabilized because the orbital that houses the lone pair has more P character.

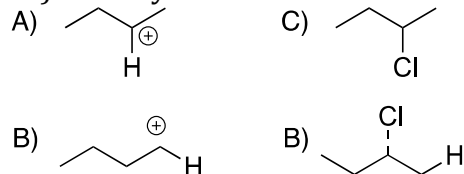
B) The conjugate base is stabilized because the orbital that houses the lone pair of electrons has more S character.

C) Because the atom with the negative charge is less electronegative

18) Predict the product of the below reaction



19) The key intermediate of the reaction above is



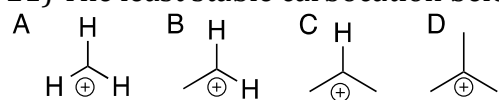
20) You get the 'markovnikov' regiochemistry (connectivity) of your product because

A) The reaction proceeds via the least stable carbocation

B) Alkenes are basic

C) The reaction goes through via the more stable carbocation

21) The least stable carbocation below is



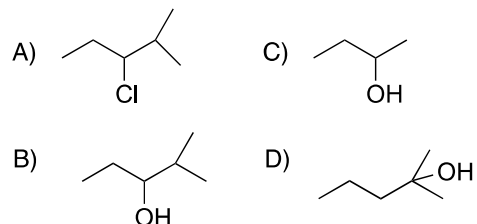
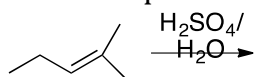
22) The hybridization of carbocations is

A) sp^3

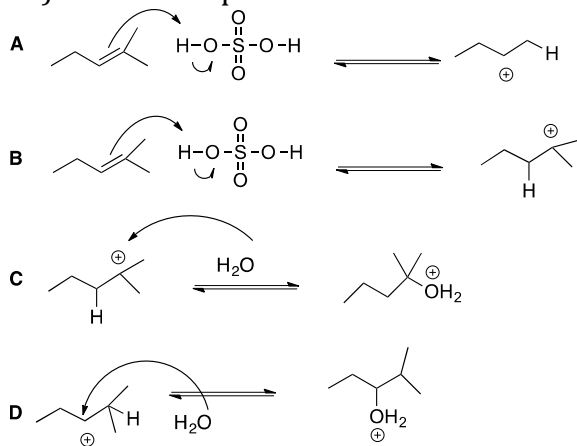
A) sp^2

A) sp

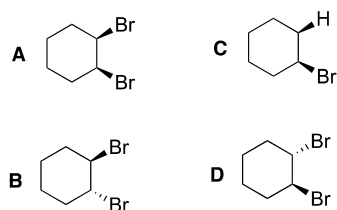
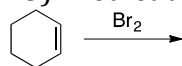
23) Predict the product of the below reaction



24) The 2nd step of the mechanism of the above reaction is



25) Predict the product of the below reaction

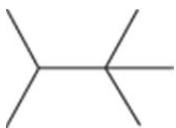


Part B. Short answer questions, 26-32, each problem is worth 5-12 points (total 61 points)

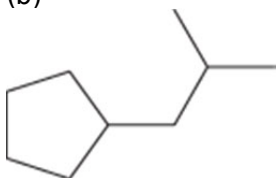
Problem 26. (9p)

Write IUPAC names for the following hydrocarbons:

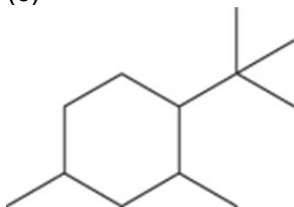
(a)



(b)

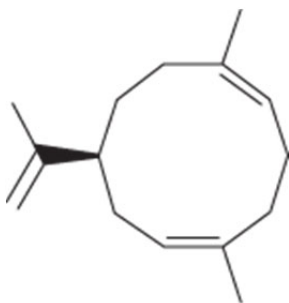


(c)



Problem 27. (12p) A) Following is the structure of Germacrene A, a hydrocarbon synthesized in plants and studied for its insecticidal properties. Classify each of the sp^3 hybridized carbons on Germacrene A as 1° , 2° , 3° , or 4° (9p)

B) Classify each alkene as E or Z respectively (3p)



Germacrene A

Problem 28. Use valence-shell electron-pair repulsion (VSEPR) to predict all bond angles about each of the following highlighted carbon atoms. (8p)

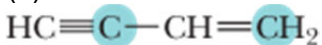
(a)



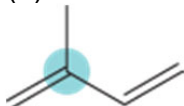
(b)



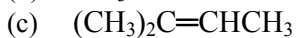
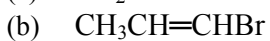
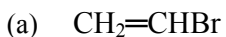
(c)



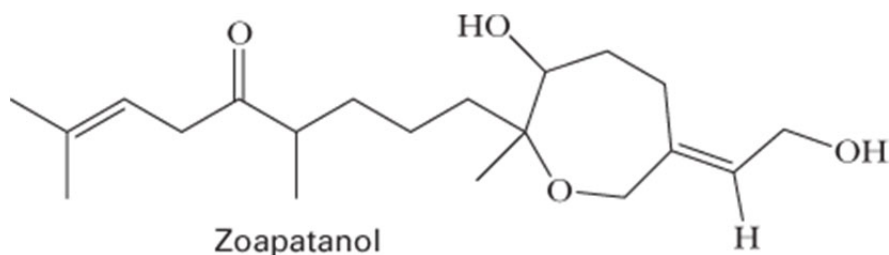
(d)



Problem 29. Which alkenes can exist as pairs of E/Z isomers?
For each alkene that does, draw both isomers. (6p)



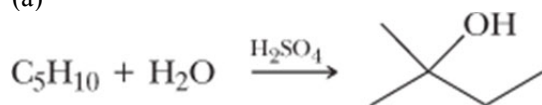
Problem 30. In many parts of South America, extracts of the leaves and twigs of *Montanoa tomentosa* are used as a contraceptive, to stimulate menstruation, to facilitate labor, and as an abortifacient. The compound responsible for these effects is zoapatanol:



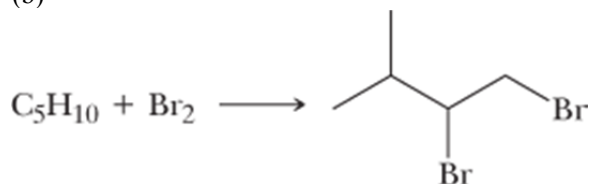
- (a) Specify the configuration about the carbon-carbon double bond to the seven-membered ring, according to the E,Z system. (3p)
- (b) How many *cis-trans* isomers are possible for zoapatanol? Consider the possibilities for *cis-trans* isomerism in cyclic compounds and about carbon-carbon double bonds. (2p)

Problem 31. Draw a structural formula for an alkene with the indicated molecular formula that gives the compound shown as the major(!) product. Note that more than one alkene may give the same compound as the major product. (9p)

(a)



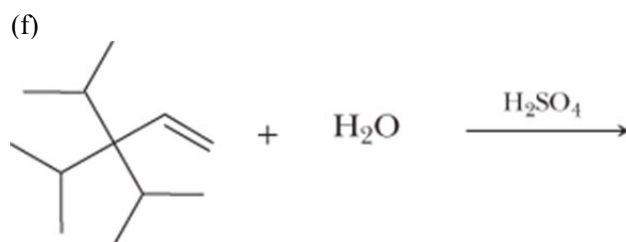
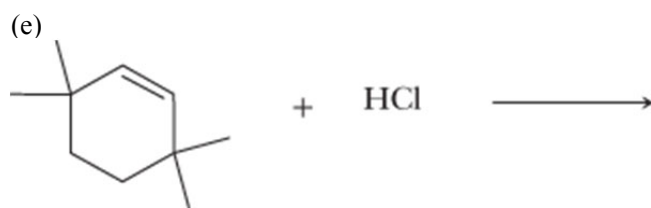
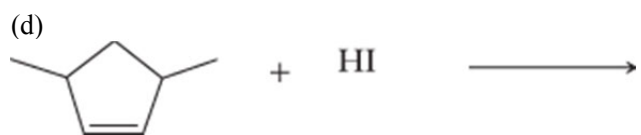
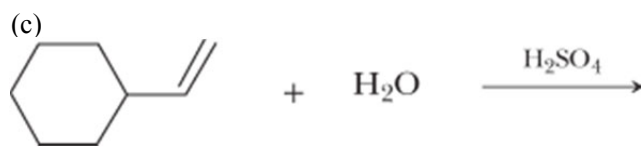
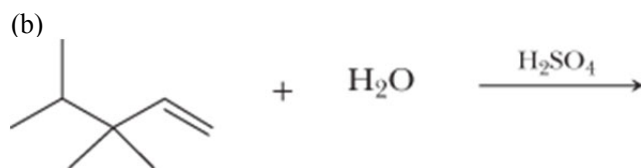
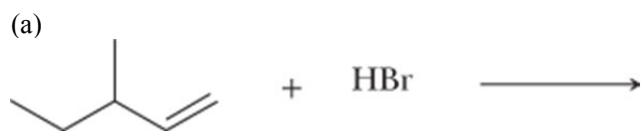
(b)



(c)



Problem 32. Complete these equations by predicting the major product formed in each reaction.
(12p)



PERIODIC TABLE OF THE ELEMENTS

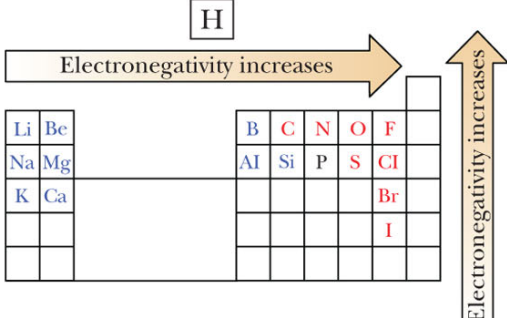
GROUP		PERIODIC TABLE OF THE ELEMENTS																		18 VIIIA																	
																				2 4.0026																	
PERIOD	1	1A																		18 VIIIA																	
	1	1	1.008																	He																	
		HYDROGEN																		HELIUM																	
	2	3	6.94	4	9.0122															10 20.180																	
		Li	Be															Ne																			
		LITHIUM	BERYLLIUM															NEON																			
	3	11	22.990	12	24.305															18 39.948																	
		Na	Mg															Ar																			
		SODIUM	MAGNESIUM															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	YTRIUM	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	HAFFNIUM	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	Fl	Uup	Lv	Uus	Uuo																			
	FRANCIUM	RADIUM	Actinide	RUTHERFORDIUM	DUBNIUM	SEABORGIUM	BOHRIUM	HASSIUM	MEITNERIUM	DARMSTADIUM	ROENTGENIUM	COPERNICIUM	UNUNTRIUM	FLEROVIUM	UNUNPENTIUM	LIVERMORIUM	UNUNSEPTIUM	UNUNOCTIUM																			

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

LANTHANIDE															
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
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	90	91	92	93	94	95	96	97	98	99	100	101	102	103	
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^-	

Grading: **Part A _____/75 points**
 Part B _____/61 points
 Total _____/136 points
Adjusted _____/150 points