Exam Booklet No.

CHEM 2410 – Organic Chemistry 1 – Fall 2017

Instructors: Paul Bracher & Erin Whitteck

Hour Examination #1

Wednesday, September 20th, 2017

6:10–8:10 p.m. in the Lecture Halls at Saint Louis University

Student Name (Printed)	
Student Signature	

Instructions & Scoring

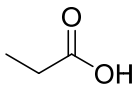
- Please write your answers on the official answer sheet. No answers marked in this booklet will be graded.
- You may use a plastic model kit. No electronic resources or note sheets are permitted, and you may not communicate with others.
- Your exam answer sheet may be copied or scanned.
- The examination room may be monitored by audio, photo, and/or video recording.

Problem	Points Earned	Points Available
I		60
II		10
III		10
IV		10
V		10
TOTAL		100

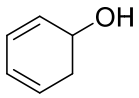
This exam focuses on Chapters 1 through 4 in Janice Smith's *Organic Chemistry*, 5th ed.

Problem I. Multiple Choice (60 points total). Correct answers score +3 points, answers of 'E' score +1 point, and incorrect answers score 0 points. Questions filled with zero or two responses will score 0 points. For each question, select the best and most complete answer of the choices given. Bubble the answer, darkly, in the space provided on the answer sheet.

(1) _____ Which of the following compounds is the <u>strongest</u> Brønsted–Lowry acid?



(A)



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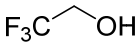
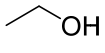
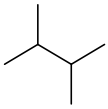


(C)



(D)

(2) _____ Which of the following compounds has the <u>highest</u> boiling point?



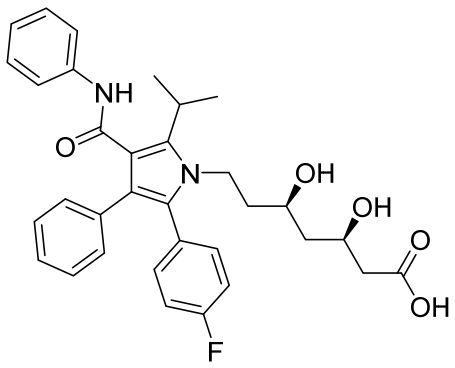
(A)

(B)

(C)

(D)

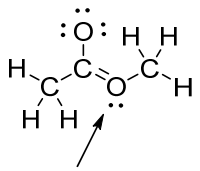
(3) _____ Which functional group is <u>not</u> present in compound **A**?



A

(A) alcohol
(B) amide
(C) carboxylic acid
(D) ester

(4) _____ What is the formal charge on the oxygen atom that is labeled with an arrow in the Lewis structure of methyl acetate (**B**) drawn below? All hydrogen atoms and lone pairs have been drawn explicitly—there are no missing implicit hydrogen atoms or lone pairs.



B

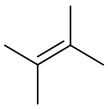
(A) −1
(B) 0
(C) +1
(D) this Lewis structure is invalid because a second-row element has too many bonds

(5) _____ What term <u>best</u> describes the relationship of structures **C** and **D**?

C **D**

(A) resonance forms
(B) constitutional/structural isomers
(C) conformational isomers
(D) *cis*/*trans* isomers

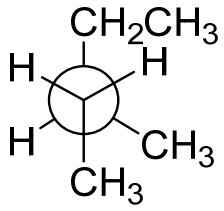
(6) _____ Which choice <u>correctly and most completely</u> describes the bonding in compound **E**?



E

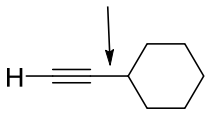
(A) <u>all</u> C–C–C bond angles are approximately 120°
(B) <u>all</u> H–C–H bond angles are approximately 109.5°
(C) both statements A and B are correct
(D) neither statement A nor statement B is correct

(7) _____ The Newman projection drawn below represents which of the following?



(A) the most-stable staggered conformation of 2,3-dimethylbutane with respect to the C2–C3 bond
(B) the most-stable staggered conformation of 3-methylpentane with respect to the C2–C3 bond
(C) a staggered conformation of 2,3-dimethylbutane, but not the most stable with respect to the C2–C3 bond
(D) a staggered conformation of 3-methylpentane, but not the most stable with respect to the C2–C3 bond

(8) _____ What orbitals form the bond between the carbon atom of the ring and the carbon atom of the adjoined ethynyl group in ethynylcyclohexane (**F**)? The bond is labeled with an arrow in the structure below.



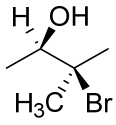
F

(A) two *sp* orbitals
(B) one *sp* orbital and one sp^3 orbital
(C) one *sp* orbital, one sp^3 orbital, and one *p* orbital
(D) one *sp* orbital, one sp^3 orbital, and two *p* orbitals

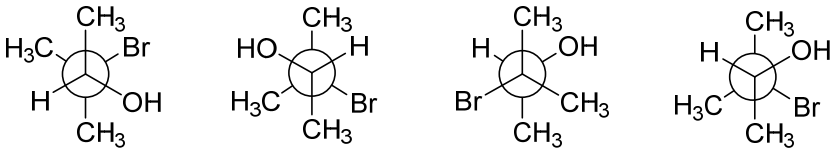
(9) _____ Which of the following statements is the most correct and complete?

(A) CH_3S^- is a stronger base than CH_3O^-
(B) the element sulfur is less electronegative than oxygen
(C) both statement A and statement B are correct
(D) none of the above statements are correct

(10) _____ Which of the following Newman projections is an accurate representation of compound **G**?



G



(A) (B) (C) (D)

(11) _____ Which of the following is <u>not</u> a valid name for an alkane based on the IUPAC system of nomenclature?

(A) 4-ethyl-3,3-dimethylheptane
(B) 3-ethyl-4,4-dimethylheptane
(C) 4,4-dipropylheptane
(D) 3-ethyl-2,2-dimethylbutane

(12) _____ Which of the following statements best describes the relative Brønsted–Lowry acidity and basicity of compounds **H** and **J**?

H **J**

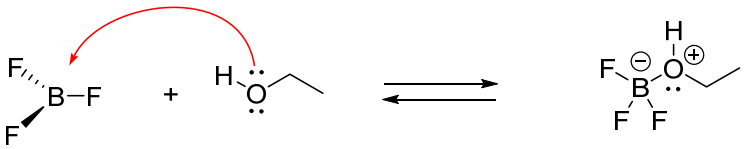
(A) compound **H** is the stronger acid and the stronger base
(B) compound **J** is the stronger acid and the stronger base
(C) compound **H** is the stronger acid, compound **J** is the stronger base
(D) compound **J** is the stronger acid, compound **H** is the stronger base

(13) _____ Rank the following compounds in order of increasing solubility in water (i.e., from the least soluble to the most soluble).

K **L** **M** **P**

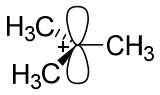
(A) **K** < **L** < **M** < **P**
(B) **P** < **L** < **M** < **K**
(C) **K** < **M** < **L** < **P**
(D) **P** < **L** < **K** < **M**

(14) _____ Which of the following statements regarding the reaction drawn below is correct?

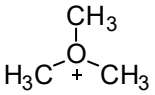


(A) the hybridization of the boron atom is sp^3 in the reactant and product
(B) the curved arrow is wrong—it should point toward the oxygen atom
(C) the alcohol reacts as a Lewis base and nucleophile
(D) the boron atom in the product should not have a −1 formal charge

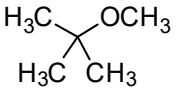
(15) _____ Which of the following compounds is formed when methoxide ($^{-}OCH_3$) reacts as a Brønsted–Lowry base with trimethylcarbenium cation (**Q**)?



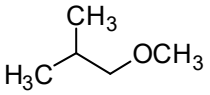
Q



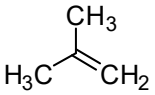
(A)



(B)



(C)

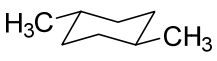


(D)

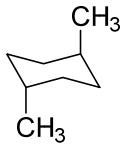
(16) _____ How many different isomers of $C_5H_{10}O$ are ketones? Recall that ketones have a carbonyl group substituted with two alkyl groups, so do not include aldehydes in your count.

(A) one
(B) two
(C) three
(D) four

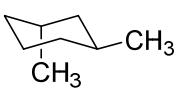
(17) _____ Which of the following structures represents the <u>most stable</u> conformation of *cis*-1,4-dimethylcyclohexane?



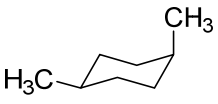
(A)



(B)

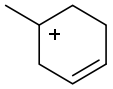


(C)

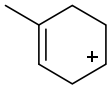


(D)

(18) _____ What statement is correct regarding cations **R** and **S**?



R



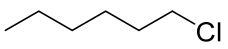
S

(A) cation **R** has two sp^2-hybridized atoms
(B) cation **S** has 12 hydrogen atoms
(C) structures **R** and **S** are resonance forms
(D) none of the above statements are correct

(19) _____ For all isomers of C_9H_{18} that are alkanes, what is the largest locant number that appears in at least one of their systematic IUPAC names?

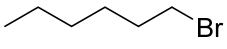
(A) 4
(B) 5
(C) 6
(D) 7

(20) _____ What concept/property best explains the difference in melting points of compounds **T** and **U**?



m.p. = –94 °C

T

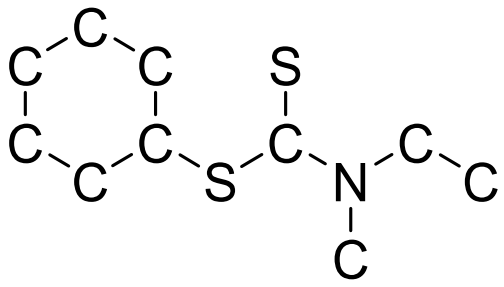


m.p. = –85 °C

U

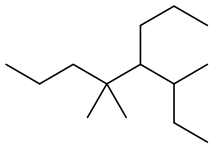
(A) net dipole moment
(B) electronegativity
(C) polarizability
(D) symmetry

Problem II. Lewis Structure (10 points). Complete the Lewis structure for compound **V** that has been started on your answer sheet. The compound has the molecular formula $C_{10}H_{13}NS_2$. The structure includes an aromatic ring, an ethyl group, and a methyl group. It is not a thiol (i.e., it does not contain a sulfhydryl group). All atoms in the structure (aside from hydrogen) have full octets and your structure should not have any formal charges. Explicitly include—i.e., draw out—all hydrogens, bonding pairs, and lone pairs on your Lewis structure.



V

Problem III. Alkanes and Substituted Alkanes (10 points). Provide the IUPAC name for compound **W**. You need not worry about stereochemistry as no information about the three-dimensional structure of the molecule is indicated.



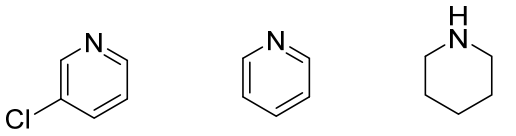
W

Problem IV. Explanation (10 points). Of acetone (**X**) and isobutylene (**Y**), which has the higher boiling point? Write the letter of your answer in the box on the answer sheet and provide a brief explanation (of no more than three sentences) for your choice. Answers of more than three sentences will receive a maximum score of three points.

X **Y**

Problem V. Explanation (10 points). The pK_a values for the conjugate acids of compounds **AA**, **BB**, and **CC** are provided below. In the box on your answer sheet, write which compound is the strongest base. Then, in no more than four sentences, provide an explanation for the relative basicity of these compounds that is consistent with the given pK_a data.

pK_a = 2.8 pK_a = 5.2 pK_a = 11.2



AA **BB** **CC**

(pK_a values are for the conjugate acids)