

Chemistry 210
“Organic Chemistry I”
Fall Semester 2000
Dr. Rainer Glaser

Examination #3

“Alkenes and Alkynes. Structure, Synthesis and Reactions.”

Friday, November 17, 2000, 9:00 - 9:50

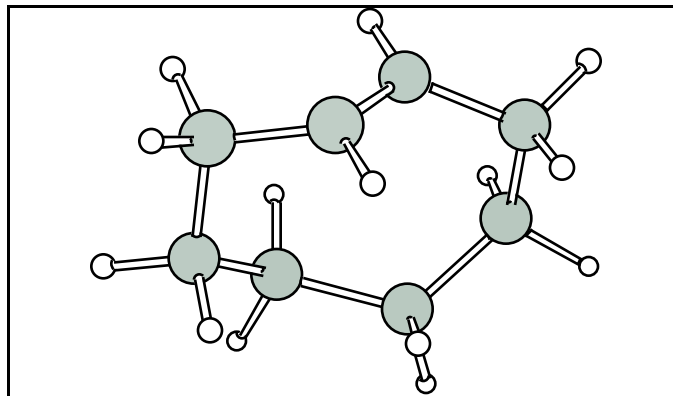
Name:

Question 1. Alkenes I. Preps & Properties.	20	
Question 2. Alkenes II. Addition Reactions. (VC #8)	20	
Question 3. Alkenes III. Oxidations. (News #8)	20	
Question 4. Alkynes I. Preps & Properties. (VC #9)	20	
Question 5. Alkynes II. Reactions.	20	
Total	100	

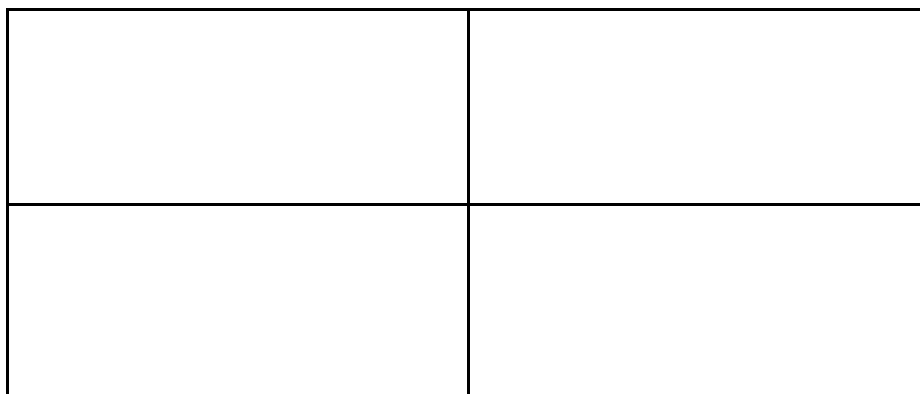
Question 1. Alkenes I. Preparations & Properties. (20 points)

(a) The molecular model is shown of a cyclic alkene. This molecule is _____ (*cis*, *trans*). Provide a suitable IUPAC name of the molecule. (3 points)

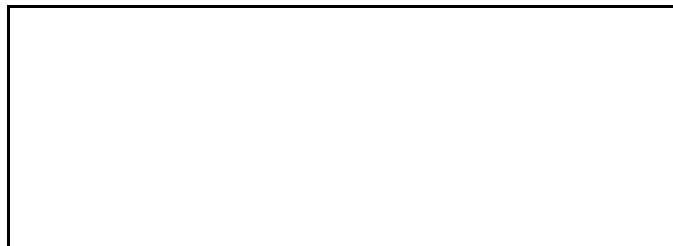
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(b) Draw Lewis structures of the 4 stereoisomers of 1-chloro-4-fluorobutadiene and indicate for each double bond whether it is *E* or *Z*. (8 points)



(c) Alkene synthesis by way of elimination from secondary alkyl halides employs bulky bases to reduce competition by nucleophilic substitution. Provide the name and the structure of one base that is typically used for this purpose. (3 points)



(d) Circle the alkene with the lowest heat of hydrogenation (the most stable alkene). (3 points)

(1) *cis*-2-butene (2) *trans*-2-butene (3) butene (4) 2-methylpropene

(e) Alkenes can be prepared by the reduction of dibromides. This elimination of bromine can be accomplished with two kinds of reagent/solvent combinations. (3 points)

Reagent 1: _____ in _____.

Reagent 2: _____ in _____.

Dibromide needs to be _____ (geminal or vicinal).

Question 2. Alkenes II. Addition Reactions. (20 points)

(a) Consider the catalytic hydrogenation of *cis*-butene to _____ (name of product). Suggest a suitable catalyst for the heterogeneous catalytic hydrogenation: _____. The hydrogenation will be _____ (endothermic, exothermic). (3 points)

(b) The bromination of *cis*-butene results in 2,3-dibromobutane. The two Br atoms will be added in a *trans* fashion because the reaction goes via a “bromonium ion”. In the

bromonium ion, one Br _____ (cation, radical, anion) is bonded to 2 C-atoms but there are only _____ electrons to form these 2 “C-Br bonds”. Draw the resonance forms that describe this “bromonium ion” and draw all lone pairs on Br. Indicate whether the resonance forms are degenerate or not. (6 p.)

(c) Suggest a preparation of butanol (the primary alcohol) from butene (a terminal alkene). Provide the structures of butene and of butanol. Specify all reagents needed. If the reaction involves several steps, then provide reagents for each step and draw the structure(s) of the intermediate(s). (6 points)

(d) Show the oxymercuration/demercuration reaction of propene. The reaction exhibits _____ (Markovnikow, anti-Markovnikow) regiochemistry. Draw the structures of the organomercurial alcohol and of the alcohol obtained after reduction with NaBD₄ (note the deuterium!) (5 p.)

The article “NEW USES FOR OLD DRUGS” (*Fort Worth Star-Telegram*, Nov. 19, **1998**) talked about minoxidil. The drug is applied by rubbing a solution of minoxidil in ethanol and propylene glycol directly on the body. So, let’s consider some aspects of diols.

Propylene	Glycol	Propylene Glycol
IUPAC:	IUPAC:	IUPAC:

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[illegible]

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Question 4. Alkynes I. Preparations & Properties. (20 points)

(a) Identify the general formula of acyclic alkynes. (2 points)

- (1) C_nH_{2n+4} (2) C_nH_{2n+2} (3) C_nH_{2n} (4) C_nH_{2n-2} (5) C_nH_{2n-4}

(b) Identify the bond length of the $C\equiv C$ bond in alkynes. (2 points)

- (1) 1.10 Å (2) 1.20 Å (3) 1.30 Å (4) 1.40 Å (5) 1.50 Å

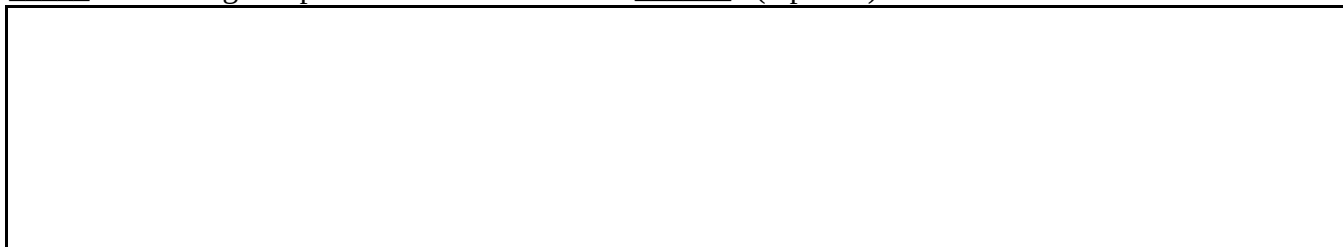
(c) Which orbital description best describes the $\equiv C-H$ bond in acetylenes? (2 points)

- (1) $C(s)-H(s)$ (2) $C(sp)-H(s)$ (3) $C(sp^2)-H(1s)$ (4) $C(sp^3)-H(1s)$

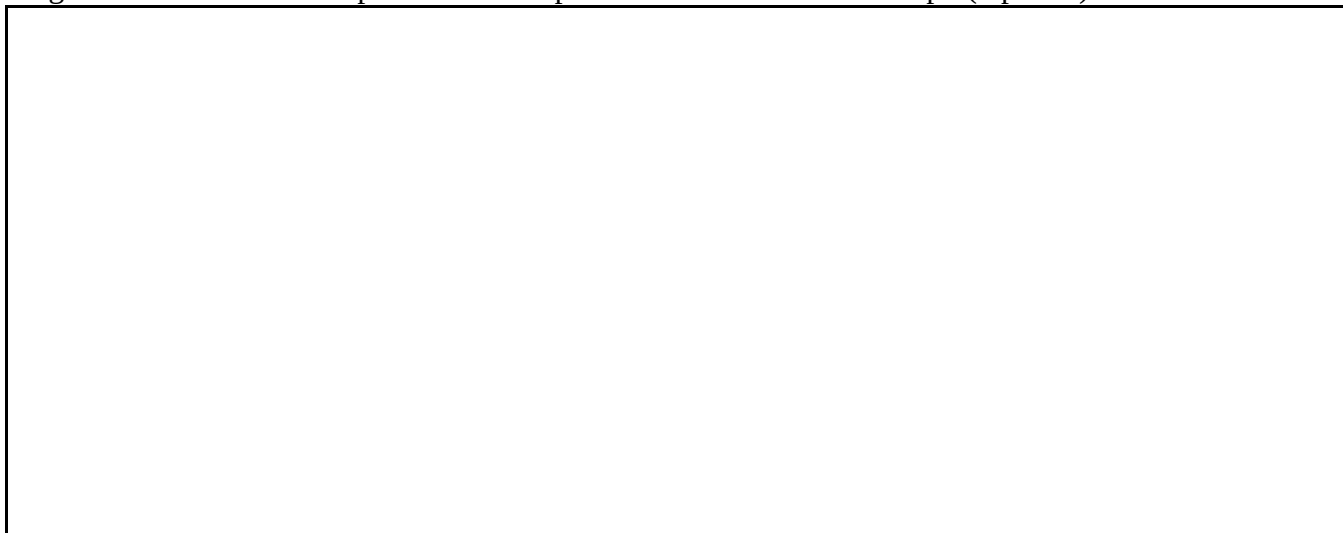
(d) Which base is best used for the deprotonation of a terminal acetylene? (2 points)

- (1) NaOH (2) NaNH₂ (3) NaCH₃ (4) NaBH₄

(e) The acetylide $CH_3-C\equiv C^- Na^+$ is treated with bromopropane. Draw the organic product of this reaction and name it using IUPAC nomenclature (VC #9). The reaction mechanism of this reaction is _____. The inorganic product of this reaction is _____. (6 points)



(f) Suggest a synthesis of butyne from butene. Draw the structures of the starting material, give the reagents needed in each step and draw the products obtained in each step. (6 points)



Question 5. Alkynes II. Reactions. (20 points)

(a) Butyne is hydrated in the presence of the catalyst HgSO_4 and a product **A** is obtained. This product **A** undergoes a rearrangement to the final product **B**. This rearrangement is a _____.

Draw the structures of butyne and of compounds **A** and **B**. (6 points)

Butyne	Compound A	Compound B

(b) Show how butanal, $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CHO}$, can be prepared from butyne via hydroboration. Draw the starting material and the products of all reaction steps. Give the reagents needed to accomplish each of the reaction steps. (6 points)

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(c) 2-butyne is treated with lithium metal in liquid ammonia. Draw the structure of the product and clearly indicate its stereochemistry. (4 points)

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(d) 2-butyne is treated with an excess of HBr. Draw the structure of the final product. (4 points)

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