

Chemistry 2030
“Survey of Organic Chemistry”
Fall Semester 2012
Dr. Rainer Glaser

Examination #1
“Bonding, Alkanes, Alkenes & Alkynes”

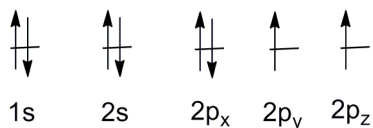
Thursday, September 13, 2012, 8:25 – 9:15 am

Name:	Answer Key
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Question 1. Atomic Structure & Lewis Structures	20	
Question 2. Nomenclature of Alkanes, Alkenes & Alkynes	20	
Question 3. Conformations of Alkanes	20	
Question 4. Reactions of Alkanes	20	
Question 5. Reactions of Alkenes & Alkynes	20	
Total	100	

Question 1. Atomic Structure and Lewis Structures. (20 points)

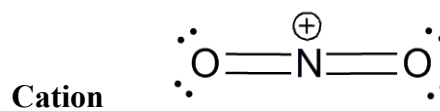
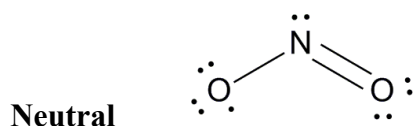
(a) Oxygen atom has 8 electrons. Provide the electron configurations of oxygen in its ground state. Use the “line format” (one short line for each AO) to indicate the number of electrons in atomic orbitals 1s, 2s, 2p_x, 2p_y, and 2p_z and indicate the spin (up or down) of the electrons. (2 points)



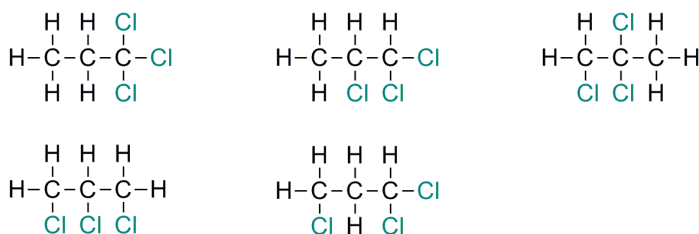
(b) Provide the approximate value of the $\angle(\text{H-O-H})$ angle in water, H₂O, and state the hybridization at O in water. (2 points)

about 109.5°, tetrahedral; sp³ hybridization

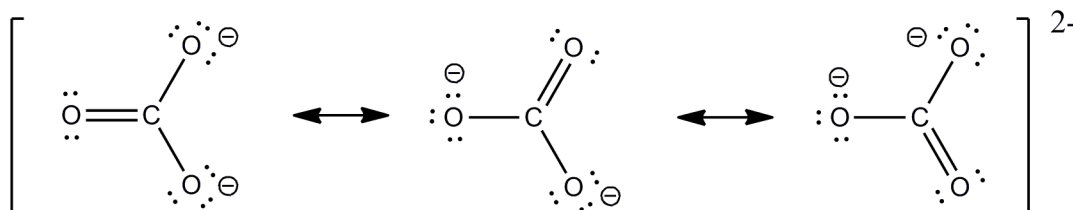
(c) Draw complete Lewis structures of **NO₂ (neutral)** and **NO₂⁺ (cation)**. Draw all lone pair, show unpaired electrons and indicate formal charges. (6 points)



(d) Draw structural formulas for all possible structure isomers with the formula **C₃H₅Cl₃**. (5 points)

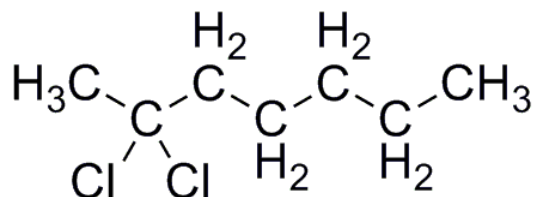


(e) Draw the three most important resonance forms of **carbonate ion, CO₃²⁻**. Draw complete Lewis structures (all lone pairs, formal charges). Use the correct “resonance arrow”. (5 points)

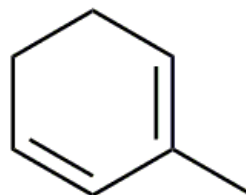


Question 2. Nomenclature of Alkanes, Alkenes & Alkynes. (20 points)

(a) Draw the abbreviated structural formula of 2,2-dichloroheptane. Draw all C–C bonds; you may abbreviate methyl groups as CH₃, a.s.o. (4 points)



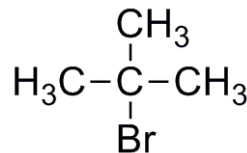
(b) Draw the line-segment formula of 2-methylcyclo-1,3-hexadiene. (4 points)



(c) Give the IUPAC name of the structure shown. (4 points)

Name:

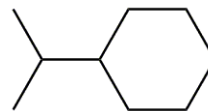
2-bromo-2-methylpropane



(d) Give the IUPAC name of the structure shown. (4 points)

Name:

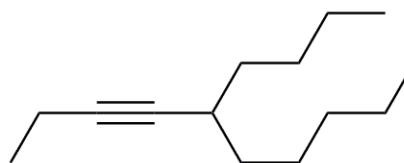
Isopropylcyclohexane



(e) Give the IUPAC name of the structure shown. (4 points)

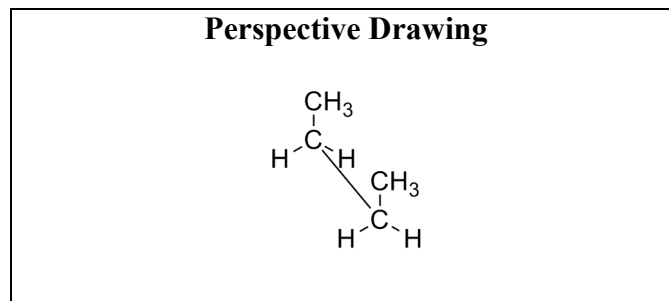
Name:

5-butyldec-3-yne

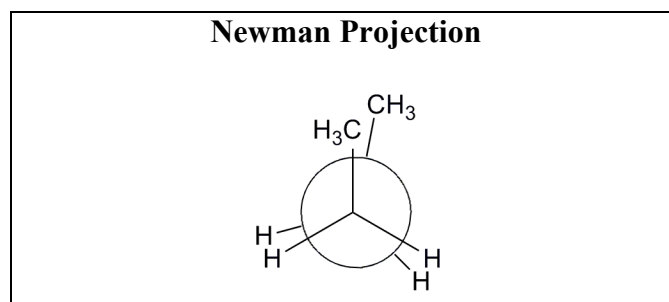


Question 3. Conformations of Alkanes. (20 points)

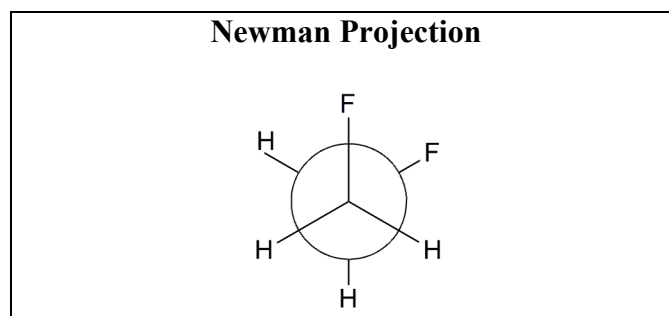
(a) Provide a perspective drawing of the *cis* conformation of butane. (4 points)



(b) Provide a Newman projection of the *cis* conformation of butane. (4 points)



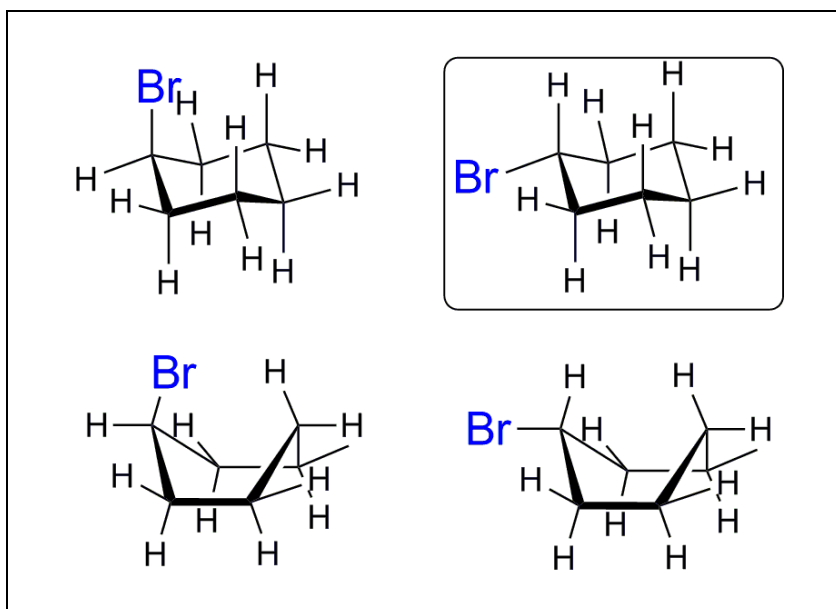
(c) Provide a Newman projection of the *gauche* conformation of 1,2-difluoroethane. (4 points)



(d) Circle the most stable conformation of the molecule shown.

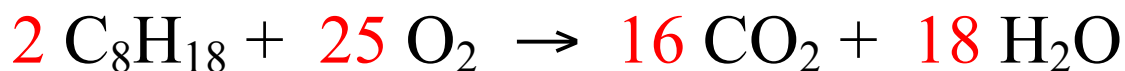
The most stable structure adopts the CHAIR conformation and the substituent prefers to be in the EQUATORIAL position.

(8 points)

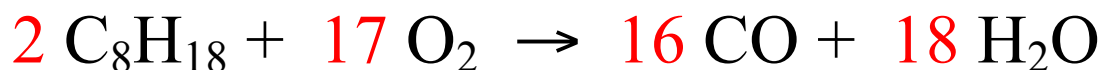


Question 4. Reactions of Alkanes. (20 points)

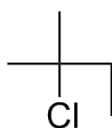
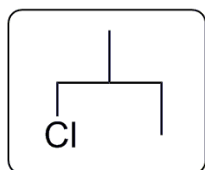
(a) Provide the stoichiometry of the **complete** combustion of octane to CO_2 . (3 points)



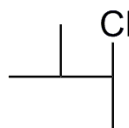
(b) Provide the stoichiometry of the **incomplete** combustion of octane to CO . (3 points)



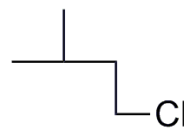
(c) Provide the structures of all possible products of **monochlorination of 2-methylbutane**. Circle the product that will be formed in the largest amount. (6 points)



1 Hs

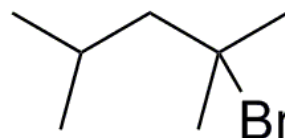


2 Hs

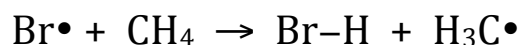
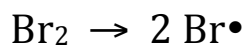


3 Hs

(d) Provide the structure of the major product of **monobromination of 2,4-dimethylpentane**. (4 points)

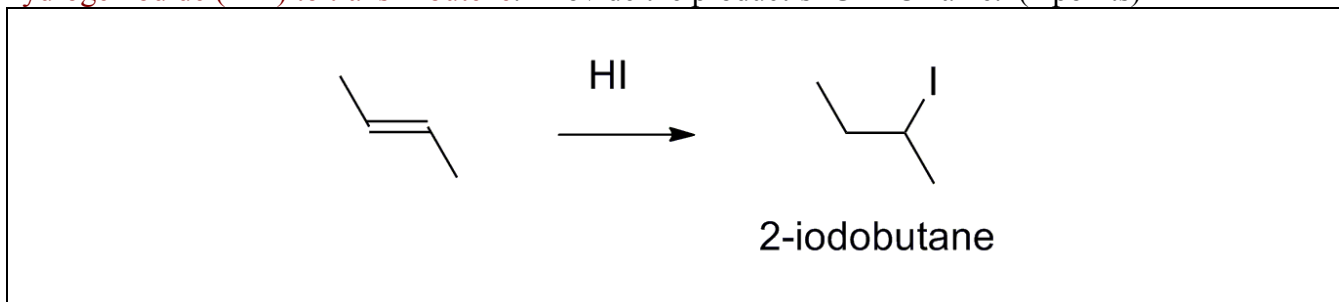


(e) Provide the reaction equations of the **initiation reaction** and the **first propagation reaction** of the radical chain bromination of methane. (4 points)

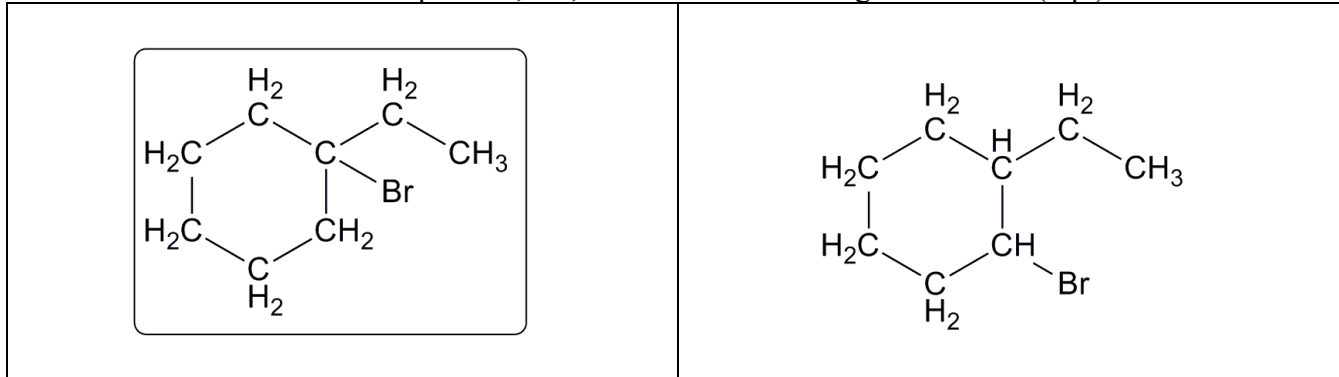


Question 5. Reactions of Alkenes and Alkynes. (20 points)

(a) Draw line-segment structures of the substrate and the product of the **electrophilic addition reaction of hydrogeniodide (H-I) to trans-2-butene**. Provide the product's IUPAC name. (4 points)



(b) Provide abbreviated structural drawings (show C-C and C-Br bonds; do not show C-H bonds, write CH, CH₂, CH₃) of the two products of the electrophilic **addition reaction of 1-ethylcyclohexene with H-Br**. Circle the Markovnikov product, i.e., the one formed in larger amounts. (4 p.)



(c) The addition of 3 molecules of **propene to borane**, BH₃, forms tri-*n*-propylborane, B(CH₂CH₂CH₃)₃. Workup with an alkaline solution of hydrogenperoxide **H₂O₂** (give formula of hydrogenperoxide) affords _____ (**primary**, secondary, tertiary) propanol. The alcohol formed in this hydroboration / oxidation sequence is the _____ (Markovnikov, **anti-Markovnikov**) product. (3 points)

(d) The Pt-catalyzed addition of **hydrogen (H₂) to 2-pentyne** initially forms **2-pentene** and this alkene then adds more hydrogen gas to form **pentane**. This Pt-catalyzed hydrogenation reaction is a _____ (homogeneous, **heterogeneous**) hydrogenation reaction. (3 points)

(e) Provide the structures of the two products of the **ozonolysis of 2-pentene** (O₃; Zn, H⁺). (4 p.)

