

CHEM 3311, Fall 2011
Professor Walba
First Hour Exam
September 22, 2011

scores:

- 1)
 - 2)
 - 3)
 - 4)
 - 5)
- _____

CU Honor Code Pledge: On my honor, as a University of Colorado at Boulder Student, I have neither given nor received unauthorized assistance.

Name (printed): _____

Signature: _____

Recitation TA Name: _____

Recitation day and time: _____

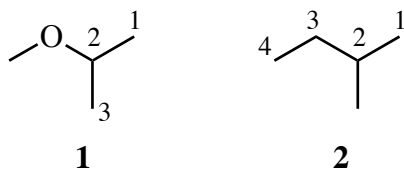
This is a closed-book exam. The use of notes, calculators, scratch paper, or cell phones will not be allowed during the exam. You may use models brought in a clear ziplock bag. Please put all you answers on the test. Use the backs of the pages for scratch.

PLEASE read the questions very carefully!

1A								8A
1 H								2 He
	2A		3A	4A	5A	6A	7A	
3 Li	4 Be		5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg		13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
							35 Br	
							53 I	

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1. (20 pts) The structures of 2-methoxypropane (1) and 2-methylbutane (2) are given below.

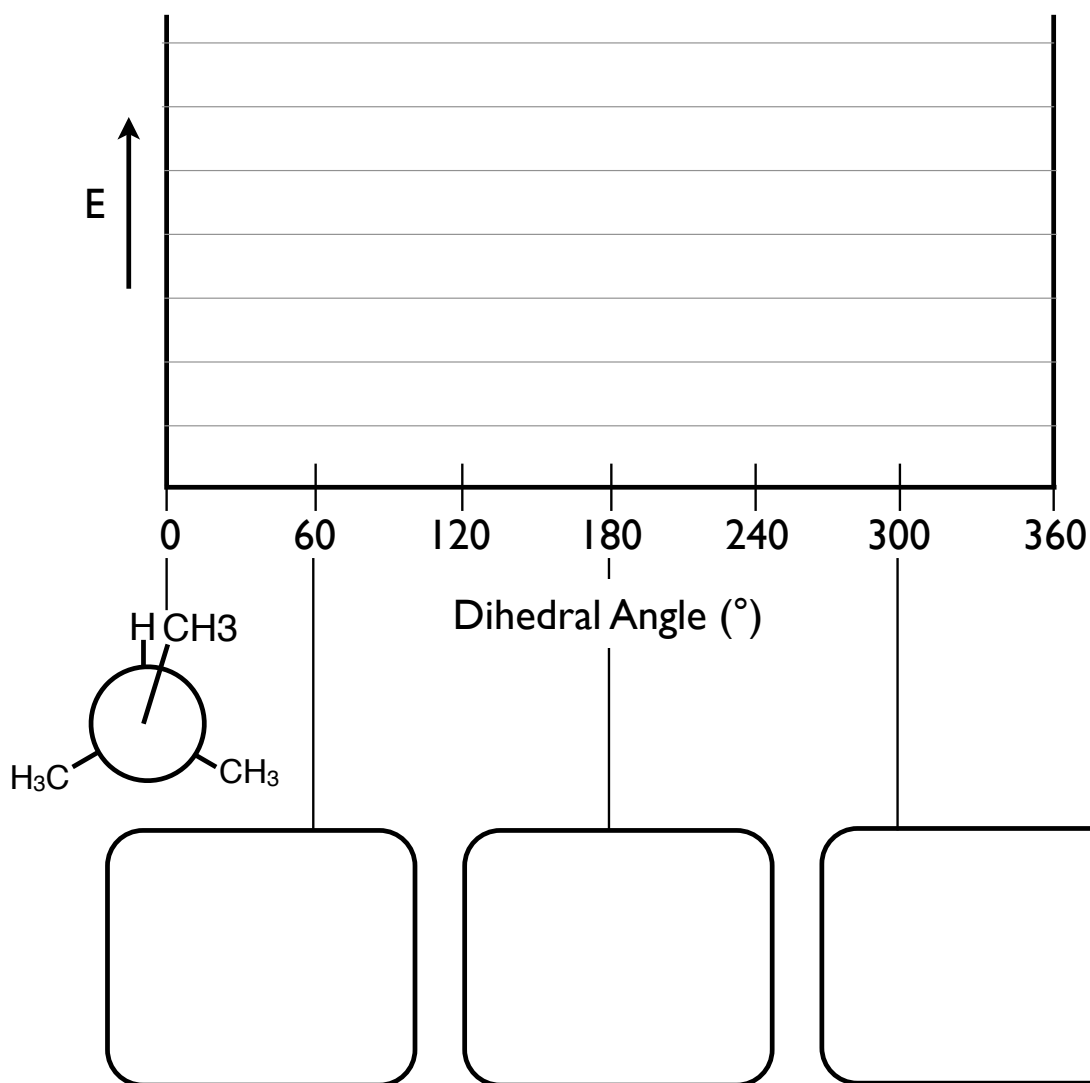


a) Is the O-C(2) bond of 1 longer or shorter than the C(2)-C(3) bond of 2?
Check the appropriate box at right to indicate your answer.

(longer shorter)

b) Perform a conformational analysis for rotation **clockwise** of the methyl group on oxygen, around the O-C(2) bond of 2-methoxypropane (1) by completing the energy diagram below. Sight down the O-C(2) bond with the oxygen atom in front. Define the conformation where the CH₃ on O is eclipsing the H atom on C(2) as having the 0° dihedral angle, as indicated by the Newman projection on the energy diagram (the CH₃ group on oxygen is rotated slightly so you can see the H atom behind it, lone pairs on oxygen are not shown).

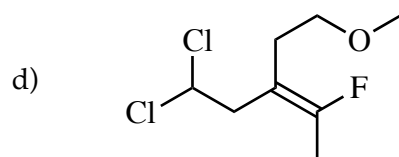
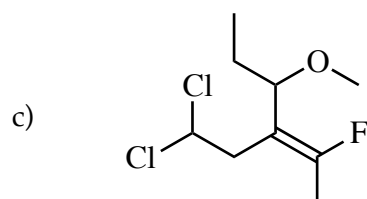
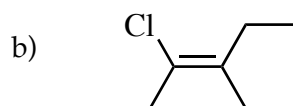
Carefully draw Newman projections for the three staggered conformations in the appropriate boxes, and complete the energy diagram showing the relative energies of all the staggered and eclipsed conformations.



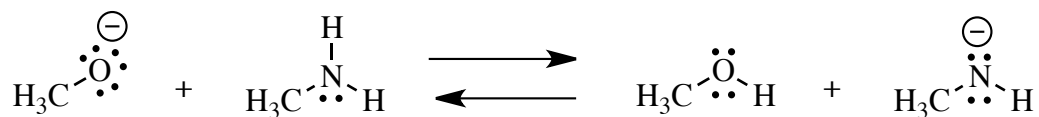
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2) (20 pts) a) Draw the structure using skeletal formulas (molecular graphs) for all possible stable isomers of C_3H_8O . Make your structures valid valence bond structures showing all lone pairs. Be careful to draw each isomer only once – points will be taken off for both missing and redundant structures.

For each of the following alkenes, indicate the stereochemical configuration (E or Z).



3) 20 pts) For the following equilibrium:

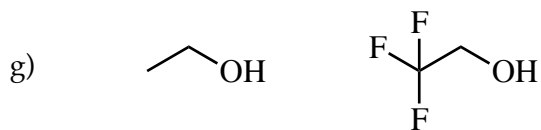
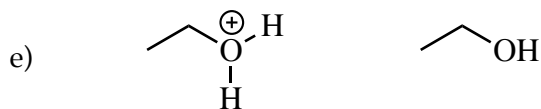


a) Label each structure above as an acid, a base, a conjugate acid, or a conjugate base (there is one of each).

b) Is K_{equ} greater than 1, or less than 1?

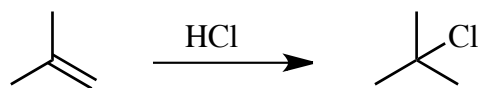
c) Which has lower energy, the starting materials or the products?

For each of the following pairs of structures, circle the stronger Brønsted acid.

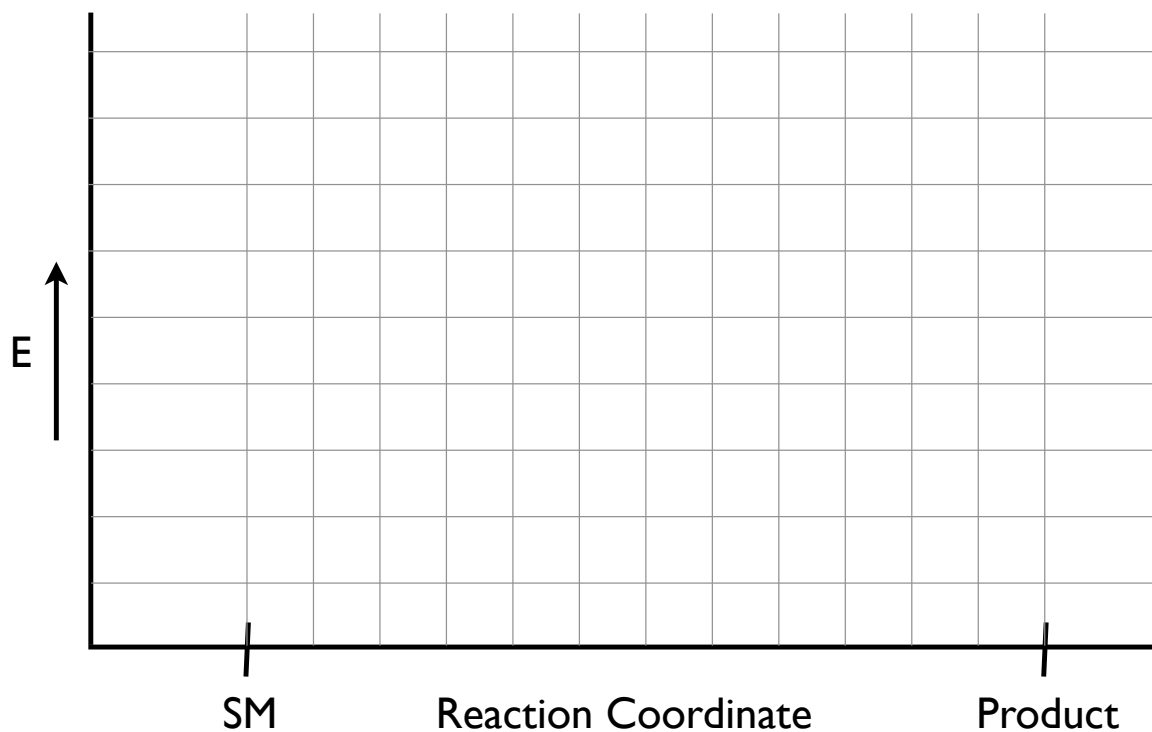


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4) (25 pts) a) Propose an arrow-pushing mechanism for the following reaction. Show all intermediates in your mechanism, but do not show transition states. Be sure all structures are complete valid valence bond structures, including all lone pairs and formal charges.



b) Complete the reaction coordinate diagram below for the reaction in part a) of this question.

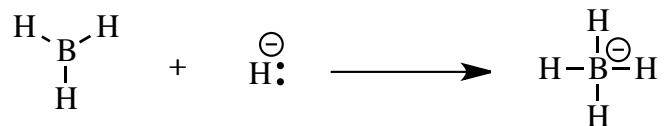


c) Draw a structure for the rate determining transition state for this reaction in the space below, and clearly indicate using an arrow where it lies on the reaction coordinate diagram.

4) –continued–

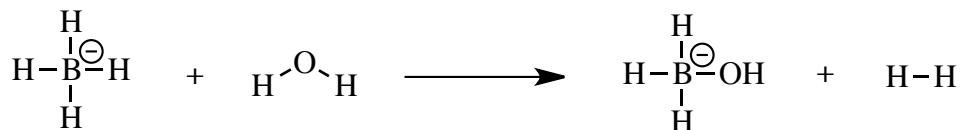
Borane (BH_3) reacts with sodium hydride ($\text{Na}^+ \text{H}^-$) to give sodium borohydride ($\text{Na}^+ \text{BH}_4^-$).

d) Propose an arrow-pushing mechanism for this reaction. Show all intermediates in your mechanism, but do not show transition states. Be sure all structures are complete valid valence bond structures, including all lone pairs and formal charges. Following a typical convention, the Na^+ ion is not shown, and is not needed in your mechanism.



e) What is the name of this type of reaction? [hint: it's a kind of acid/base reaction]

f) Sodium borohydride reacts with water to give hydrogen gas and "hydroxyborohydride," as shown in the equation below (again, the Na^+ ion is not shown). Give an arrow-pushing mechanism for this reaction, using valid valence bond structures with all lone pairs and formal charges correctly indicated.



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5) (15 pts) Based upon what you've learned, it's not possible to decide which of the following molecules is the stronger Brønsted acid. However, it is possible to make an argument for either molecule being the stronger acid.



1



2

a) In the space just below this sentence, make a **concise** argument for why 2,2,2-trifluoroethanol (**1**) would be a stronger acid than ethanethiol (**2**).

b) In the space below, make a **concise** argument for why ethanethiol (**2**) would be a stronger acid than 2,2,2-trifluoroethanol (**1**).

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5) – Continued

c) Give an arrow-pushing mechanism for the following reaction. Show all intermediates in your mechanism, but do not show transition states. Be sure all structures are complete valid valence bond structures, including all lone pairs and formal charges.

