Department of Chemistry
SUNY/Oneonta

Chem 221 - Organic Chemistry I

Examination #2 - October 18, 2004

INSTRUCTIONS —

This examination is in multiple choice format; the questions are in this Exam Booklet and the answers should be placed on the "Test Scoring Answer Sheet" which must be turned in and will be machine graded.

On the Test Scoring Answer Sheet, using a soft pencil, enter the following data (in the appropriate places):

> your name,

> your OSC Student (**not Social Security**) number (enter the entire number but do not darken a bubble under the letter), and

> course number (30022101);

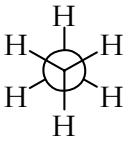
darken the appropriate bubbles under the entries, making dark black marks which fill the bubbles.

You may use a set of molecular models and the periodic table at the end of the exam, but no other aids, during the exam.

Answer all questions. The questions are worth 4.17 points each.

You have 50 minutes. Good luck!

1. A representation of ethane is shown to the right. This type of representation is called



(a) a sawhorse projection. (b) a Newman projection.
(c) a Lewis structure. (d) a resonance structure.

2. The figure of ethane in question #1 represents the

(a) staggered conformation. (b) staggered configuration. (c) eclipsed conformation.
(d) eclipsed configuration.

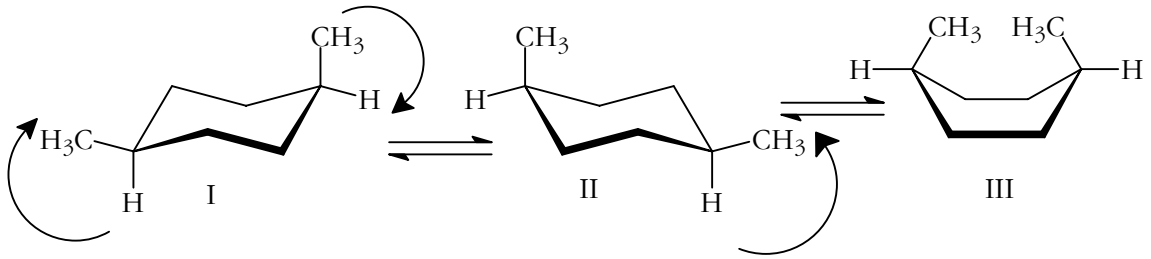
3. Consider rotation around the C(2)-C(3) bond of butane. Which of the following conformations has both torsional and steric strain?

(a) anti-periplanar, (b) anti-clinal, (c) syn-clinal, (d) syn-periplanar

4. Cyclohexane has a puckered rather than a flat structure. The puckered structure is favored over the flat one because the puckered one has less _____ strain.

(a) angle and torsional, (b) angle and steric, (c) torsional and steric,
(d) eye, (e) brain

The following figure relates to questions 5-7.



The curved arrows demonstrate how a ring is "flipped" to generate the structure to its right.

5. Which statement about the compound shown above is correct?

(a) Boat conformations I & II are of equal stability and they are more stable than chair conformation III.
(b) Chair conformations I & II are of equal stability and they are more stable than boat conformation III.
(c) Boat conformations I & II are of equal stability and they are less stable than chair conformation III.
(d) Chair conformations I & II are of equal stability and they are less stable than boat conformation III.

6. Which statement about the above compound is correct?

(a) I is a configurational isomer of II and II is a configurational isomer of III.
(b) I is a conformational isomer of II and II is a configurational isomer of III.
(c) I is identical with II and II is a configurational isomer of III.
(d) I is a configurational isomer of II and II is a conformational isomer of III.
(e) I is a conformational isomer of II and II is a conformational isomer of III.
(f) I is identical with II and II is a conformational isomer of III.

7. What is the best name for the compound above?

(a) *cis*-1,4-dimethylhexane, (b) *trans*-1,4-dimethylhexane,
(c) *cis*-1,4-dimethylcyclohexane, (d) *trans*-1,4-dimethylcyclohexane,
(e) None of the previous answers is correct.

8.

$$H_2C{=}CH_2 \quad + \quad H{-}Br \quad \longrightarrow \quad H_3C{-}CH_2Br$$

The above reaction can be characterized as

(a) an addition reaction. (b) an elimination reaction. (c) a substitution reaction.
(d) a rearrangement reaction.

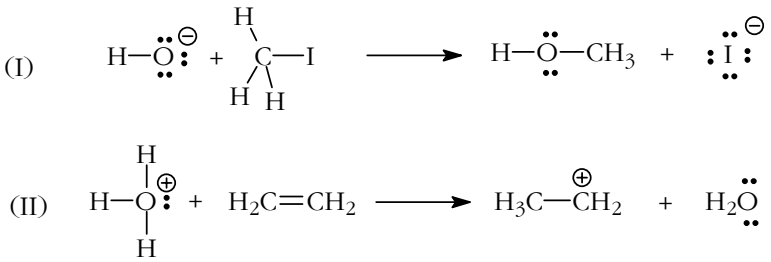
9. Alkane chlorination is not a generally useful reaction because most alkanes have several different kinds of hydrogens, causing mixtures of chlorinated products to result. How many structurally isomeric monochloro substitution products would you obtain by reaction of 2-methylpentane with Cl_2.

$$\begin{array}{c} CH_3 \\ | \\ CH_3CHCH_2CH_2CH_3 \end{array}$$

2-methylpentane

(a) 1, (b) 3, (c) 4, (d) 5, (e) 6

10. Select the statement below that accurately describes the nature of the carbons in the reactants in the two one-step reactions shown to the right.



(a) The carbon in (I) is electrophilic and one or both of the carbons in (II) are electrophilic.
(b) The carbon in (I) is electrophilic and one or both of the carbons in (II) are nucleophilic.
(c) The carbon in (I) is nucleophilic and one or both of the carbons in (II) are electrophilic.
(d) The carbon in (I) is nucleophilic and one or both of the carbons in (II) are nucleophilic.

11-12. In the table to the right below you will find values of ΔG^o, the standard free energy changes, for three different reactions ("A", "B", and "C").

Reaction	ΔG^o, kJ/mol
"A"	-30
"B"	0
"C"	30

11. Which of the following statements is correct with regard to the equilibrium constants for reactions A, B, and C?
[$K_A > K_B$ means K_A is larger than K_B.
$K_A < K_B$ means K_A is smaller than K_B.]

(a) $K_B = 1$, and $K_A > K_B > K_C$,
(b) $K_B = 1$, and $K_A < K_B < K_C$,
(c) $K_B = 0$, and $K_A > K_B > K_C$,
(d) $K_B = 0$, and $K_A < K_B < K_C$,
(e) Bogus question, dude! One cannot answer this question based on the information provided.

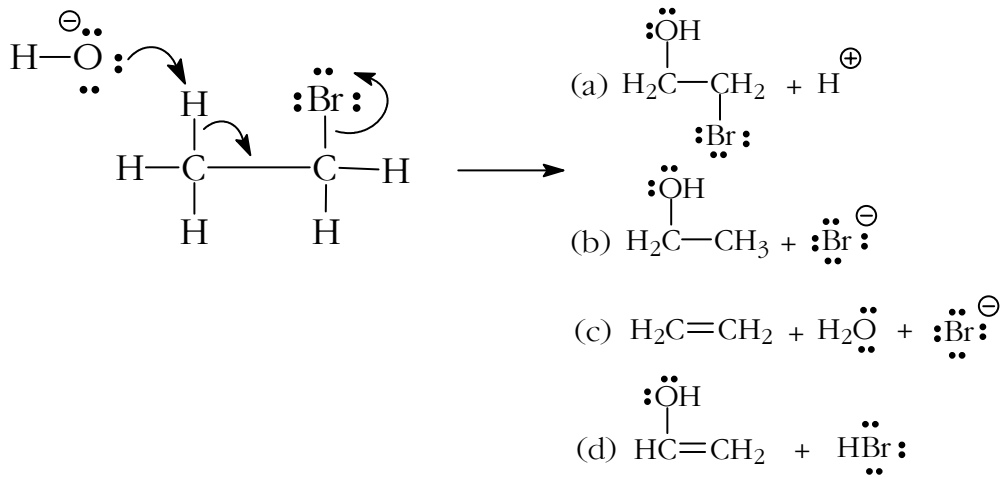
12. Use the data given in the table in question #11 and assume reactions "A", "B", and "C" are one-step reactions What is the very smallest (minimum) theoretically possible free energy of activation ($\Delta G^{\ddagger}$) for reactions "A", "B", and "C". Select the column (a, b, c or d) from the table below that provides the correct answer.

Reaction	(a) minimum $\Delta G^{\ddagger}$, kJ/mol	(b) minimum $\Delta G^{\ddagger}$, kJ/mol	(c) minimum $\Delta G^{\ddagger}$, kJ/mol	(d) minimum $\Delta G^{\ddagger}$, kJ/mol
"A"	-30	0	30	30
"B"	0	0	0	30
"C"	30	30	-30	30

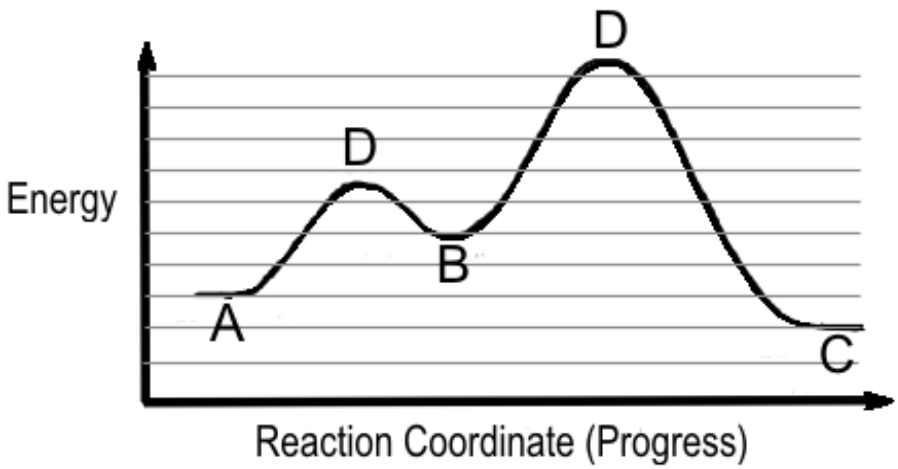
13. In a polar reaction bonds are broken _____, while in a free radical reaction they are broken _____.

(a) heterolytically, homolytically, (b) heterogenically, homogenically,
(c) homolytically, heterolytically, (d) homogenically, heterogenically

14. Predict the products of the following reaction by interpreting the flow of electrons as indicated by the curved arrows.



For questions 15-18 consider the reaction coordinate (reaction energy) diagram to the right. This diagram represents a two-step reaction.



15. Reactants, if any, in this reaction are labeled:

(a) A, (b) B, (c) C, (d) D, (e) There are no reactants in this reaction.

16. Intermediates, if any, in this reaction are labeled:

(a) A, (b) B, (c) C, (d) D, (e) There are no intermediates in this reaction.

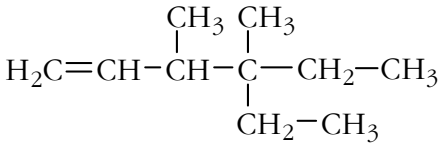
17. Transition states, if any, in this reaction are labeled:

(a) A, (b) B, (c) C, (d) D, (e) There are no transition states in this reaction.

18. The rate limiting (rate determining) step in this reaction is likely to be the _____ step.

(a) first, (b) second, (c) third, (d) fourth. (e) Bogus question, dude. In a multi-step reaction there is no such thing as a rate limiting step.

19. Select the IUPAC name for the compound shown to the right.



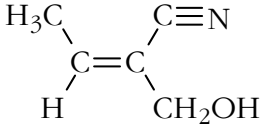
(a) 3,4,4-trimethyl-1-hexene,
(b) 4-ethyl-3,4-dimethyl-1-pentene,
(c) 3,4,4-trimethyl-1-hexene,
(d) 2-ethyl-2,3-dimethyl-4-pentene,
(e) None of the above answers is correct.

20. Which of the following compounds can exist as pairs of cis-trans isomers?

(I) $CH_3CH{=}CH_2$, (II) $CH_3CH{=}CHCH_3$, (III) $CH_3CH_2CH{=}CHCH_3$,
(IV) $(CH_3)_2C{=}C(CH_3)CH_2CH_3$, (V) $ClCH{=}CHCl$, (VI) $BrCH{=}CCl_2$

(a) I & III, (b) II & IV, (c) II, III & V, (d) IV, V & VI, (e) None of the previous answers is correct.

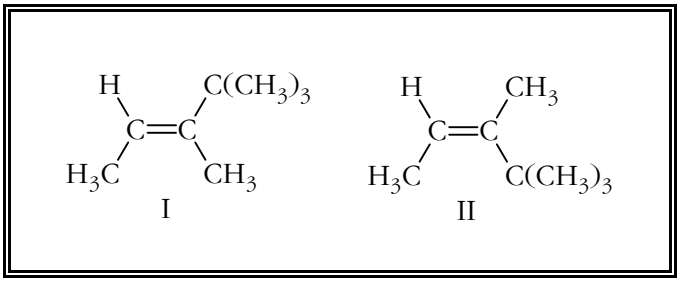
21. Specify the configuration around the double bond in the compound shown to the right using the Cahn-Ingold-Prelog system. [Atomic numbers: H=1, C=6, N=7, O=8]



(a) A, (b) B, (c) E, (d) X, (e) Y, (f) Z

22. What is the relationship between the two molecules shown to the right?

(a) There is no relationship.
(b) They are constitutional isomers.
(c) They are conformational stereoisomers.
(d) They are geometric (cis-trans) stereoisomers.
(e) They are stereoisomers, but not of the geometric type.



23. Rank the following alkenes in order of decreasing stability (most stable first).

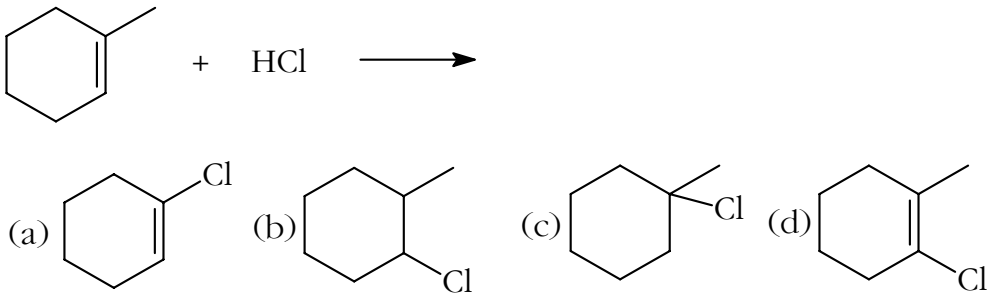
(I) 1-butene, (II) trans-2-butene, (III) cis-2-butene, (IV) 2-methyl-2-butene,
(V) 2,3-dimethyl-2-butene

(a) I>II>III>IV>V, (b) V>IV>III>II>I, (c) V>IV>II>III>I, (d) I>III>II>IV>V,
(e) None of the above answers is correct.

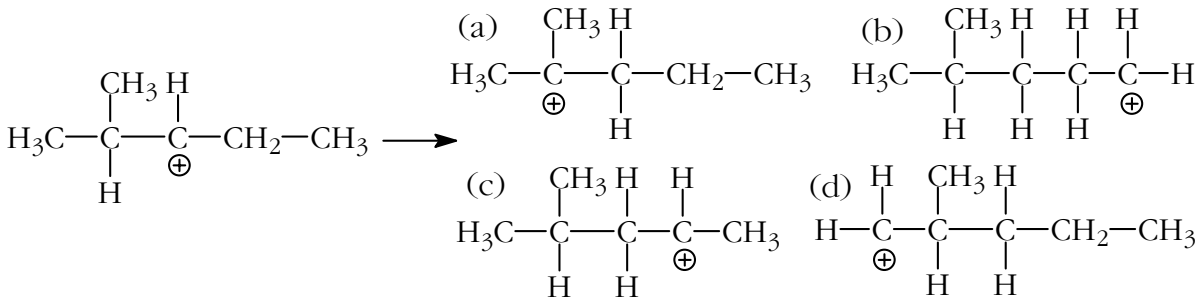
24. Rank the classes (methyl, 1°, 2°, 3°) of carbocation in order of decreasing stability (most stable first).

(a) methyl > 1° > 2° > 3°, (b) methyl > 1° > 3° > 2°, (c) methyl > 2° > 1° > 3°,
(d) 3° > 2° > 1° > methyl

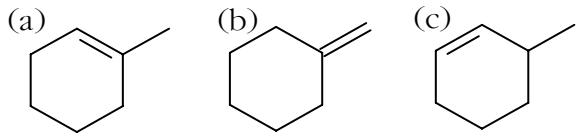
25. Select the major product of the following reaction.



26. Which of the carbocations shown to the right below would be produced upon rearrangement of the carbocation to their left?



27. Which of the following alkenes would be the best choice to react with HI in the preparation of 1-iodo-1-methylcyclohexane. ("Best choice" means pick the alkene that will produce 1-iodo-1-methylcyclohexane in highest yield with the fewest byproducts.)



(d) None of these alkenes would give a good yield of the desired product.

28. The double bond in a alkene consists of

(a) two σ-bonds, (b) one σ-bond and one π-bond, (c) two π-bonds, (d) None of the previous answers is correct.

29. The Markovnikov rule states that in the ionic addition of H-X to a double bond of an alkene the hydrogen of H-X will attach to the doubly bonded carbon that holds

(a) more hydrogens. (b) fewer hydrogens. (c) more carbons. (d) fewer carbons.

30. The theoretical underpinning for the empirical Markovnikov rule is that in the ionic addition of H-X to a double bond of an alkene

(a) the more stable free radical forms faster.
(b) the less stable free radical forms faster.
(c) the more stable carbocation forms faster.
(d) the less stable carbocation forms faster.