

# Solutions

Department of Chemistry  
SUNY/Oneonta

Chem 221 - Organic Chemistry I

Examination #1 - September 25, 2000

## INSTRUCTIONS —

This examination has two parts. The first part 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.

The second part requires your responding to questions in this Exam Booklet by writing answers into the spaces provided. The Exam Booklet must be handed in and will be returned to you with a grade.

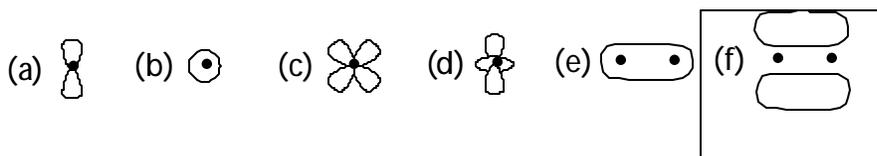
On the Test Scoring Answer Sheet, using a soft pencil, enter the following data (in the appropriate places): your name, instructor's name, your student (Social Security) number, course number (30022101) and the test number (01); darken the appropriate bubbles under the entries, making dark black marks which fill the bubbles.

You may use a set of molecular models and the tables provided, but no other aids, during the exam.

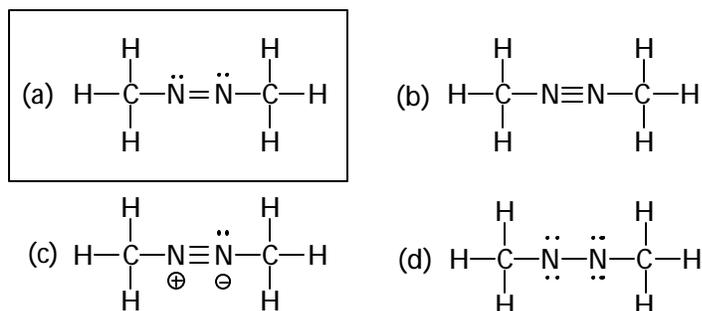
Answer all questions. The questions on Part I are worth 2 points each.

You have 90 minutes. Good luck!

1. One can expect that two atoms will form a covalent, rather than ionic, bond if
- (a) the sum of the electronegativities of the two atoms is less than 1.7.
  - (b) the sum of the electronegativities of the two atoms is more than 1.7.
  - (c) the difference between the electronegativities of the two atoms is less than 1.7.
  - (d) the difference between the electronegativities of the two atoms is more than 1.7.
2. Fill in the blanks.  
In 1828 Friedrich Wöhler synthesized \_\_\_\_\_ from ammonium cyanate \_\_\_\_\_. This accomplishment put an end to the \_\_\_\_\_ which stipulated that a living organism was required to convert inorganic compounds to organic ones.
- (a) glycine - *in vitro* - theory of relativity, (b) glycine - *in vivo* - vital force theory,
  - (c) urea - *in vitro* - vital force theory, (d) glucose - *in vitro* - big bang theory
3. Which of the following statements about orbitals is (are) *true*?
- (I) The atomic 2p orbitals are dumbbell shaped (8).
  - (II) When a 2s and one 2p orbital in an atom combine to form hybrid orbitals, two  $sp^3$  orbitals form.
  - (III) If two atomic p orbitals on adjacent atoms combine in parallel fashion one  $\sigma$  and one  $\sigma^*$  molecular orbital will result.
  - (IV) If two  $sp^2$  hybridized atoms are bonded together, typically an  $sp^2$  orbital on one will combine with an  $sp^2$  orbital on the other to form a  $\sigma$  and a  $\sigma^*$  orbital.
- (a) I only, (b) II only, (c) III only, (d) IV only, (e) I&IV, (f) II&IV
4. Which of the figures shown below is a reasonable representation of a  $\pi$  orbital? [Nuclei are shown as dots.]

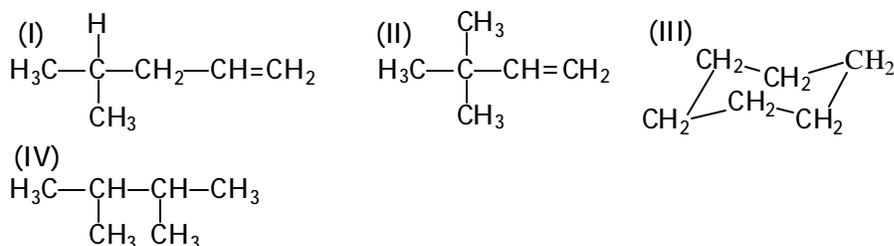


5. Which of the Lewis structures shown below is correct?



(b) is short 2 electrons. (c) has 10 valence electrons around the right N. (d) has 2 too many electrons.

6. Which of the molecules shown below are *not* constitutional (structural) isomers of  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}=\text{CH}_2$ ?



I is the same compound. IV has a different molecular formula. II and III have the same molecular formula and different atomic connections.

(a) I only, (b) II only, (c) III only, (d) IV only, (e) I&III, (f) I&IV

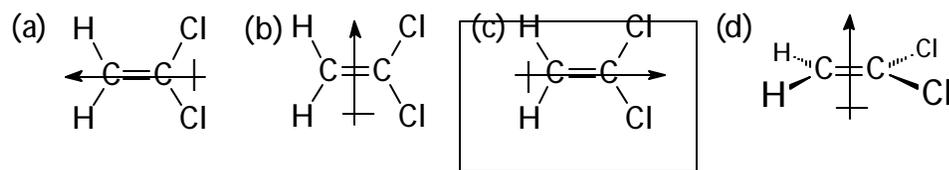
7. What is the shape of the carbon atoms in propane?

(a) linear, (b) trigonal, planar, (c) tetrahedral, (d) octahedral

8. What is the hybridization of the carbon atoms in propane?

(a)  $sp$ , (b)  $sp^2$ , (c)  $sp^3$ , (d)  $d^2sp^3$

9. Select the figure which correctly shows the direction of the dipole moment in  $\text{CH}_2=\text{CCl}_2$ .

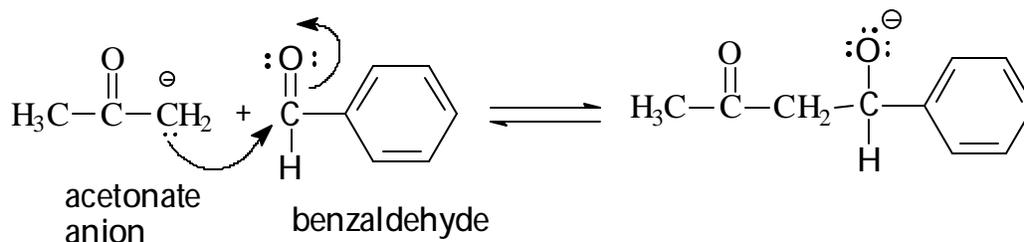


10. Which of the covalent bonds shown below is the most polar?



Oxygen is the most electronegative element of those attached to the  $\text{CH}_3$ .

[11-12] One of the reaction steps in the formation of dibenzalacetone from acetone and benzaldehyde involves the reaction of acetone anion with benzaldehyde as shown below.



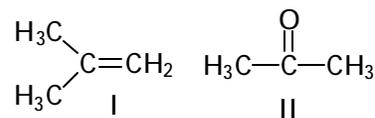
11. This reaction can be characterized as

- (a) a Lowry-Bronsted acid-base reaction, only.  
 (b) a Lewis acid-base reaction, only.  
 (c) both a Lowry-Bronsted and Lewis acid-base reaction.  
 (d) Bogus question! This is not an acid-base reaction.

12. Which of the following statements best describes the character of the reactants above?

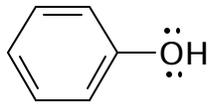
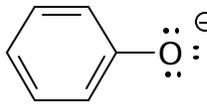
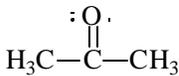
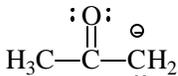
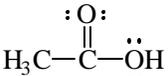
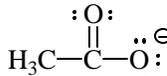
- (a) Acetone anion is a base and benzaldehyde is an acid.  
 (b) Acetone anion is an acid and benzaldehyde is a base.  
 (c) Acetone anion and benzaldehyde cannot be characterized as acids or bases.  
 (d) Both of these reactants function as both acid and base.

13. To what functional group family do the two compounds shown to the right belong?



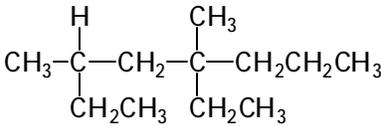
- (a) I-alkyne, II-aldehyde, (b) I-arene, II-carboxylic acid,  
 (c) I-alcohol, II-ester, (d) I-alkene, II-ketone

14. Rank the bases in the table below in order of decreasing basicity (most basic first). The  $pK_a$  values of the conjugate acids of the bases are also shown in the table.

Acid	$pK_a$	Base
HCl	-6	$Cl^-$ (I)
	9.9	 (II)
	19	 (III)
	4.8	 (IV)

(a) I>II>III>IV, (b) IV>III>II>I, (c) III>II>IV>I, (d) I>IV>II>III, (e) IV>II>III>I

The strength of an acid and the basicity of its conjugate base are inversely related. The strongest acid is HCl and  $Cl^-$  is the weakest base.

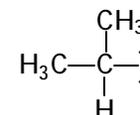
15. The general molecular formula for *acyclic* alkanes is \_\_\_\_\_, while the general molecular formula for *cyclic* alkanes containing *one ring* is \_\_\_\_\_.
- (a)  $C_nH_{2n+2} / C_nH_{2n}$ , (b)  $C_nH_{2n} / C_nH_{2n+2}$ , (c)  $C_nH_{2n} / C_nH_{2n-2}$ , (d)  $C_nH_{2n+2} / C_nH_{2n+2}$
16. How many configurational isomers are there for  $C_5H_{12}$ ? [Hint: Draw them out and count them up.]
- (a) 3, (b) 4, (c) 5, (d) 6, (e) 7, (f) 8
- They are pentane, 2-methylbutane, and 2,2-dimethylpropane.
17. Select the correct IUPAC name for the compound to the right.
- 
- (a) 2,4-diethyl-4-methylheptane, (b) 1,3-diethyl-1,3-dimethylhexane,  
(c) 5-ethyl-3,5-dimethyloctane, (d) 4,6-diethyl-4-methylheptane
18. How many  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  and  $4^\circ$  carbons are present in the compound in question #17? [Select

the correct row in the table below, or answer (e).]

	1°	2°	3°	4°
(a)	2	5	3	2
(b)	<u>5</u>	<u>5</u>	<u>1</u>	<u>1</u>
(c)	6	3	2	1
(d)	4	4	3	1

(e) None of the above answers is correct.

19. The alkyl group shown to the right is known as

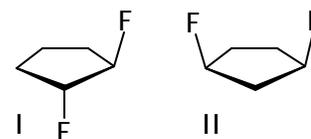


(a) isopropyl. (b) propyl. (c) isobutyl. (d) *sec*-butyl. (e) *tert*-butyl.  
(f) Michael.

20. Alkane molecules are attracted to each other because of

(a) London or van der Waals forces. (b) dipole-dipole attractions. (c) ionic bonds.  
(d) love. (e) lust.

21. What is the relationship between I & II?



(a) They are the same molecule.  
(b) They are constitutional (structural) isomers.  
(c) They are stereoisomers.  
(d) They are conformational isomers.

22. What is the name of compound II in question #21?

(a) *cis*-1,4-difluorocyclopentane, (b) *trans*-1,4-difluorocyclopentane,  
(c) *cis*-1,3-difluorocyclopentane, (d) *trans*-1,3-difluorocyclopentane

23. 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

24. Considering rotation around the C(2)-C(3) bond of butane, which of the following

conformations is least stable?

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

25. Consider the following statement: "In relation to question 24, in a sample of butane at room temperature, none of the molecules will be in the least stable conformation."

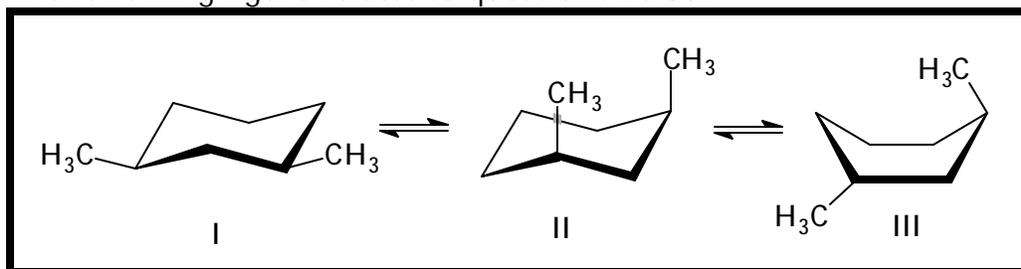
(a) The above statement is true.

(b) The above statement is false. All of the indicated (anti-periplanar, anti-clinal, etc.) conformations of butane will be equally populated.

(c) The above statement is false. All of the indicated conformations of butane will be populated, but the more stable ones will have smaller populations.

(d) The above statement is false. All of the indicated conformations of butane will be populated, but the more stable ones will have larger populations.

The following figure relates to questions 26-30.



26. Which conformation of the compound shown above is *most* stable?

(a) I, (b) II, (c) III, (d) The conformations shown are of equal stability.

27. Which conformation of the compound shown above is *least* stable?

(a) I, (b) II, (c) III, (d) The conformations shown are of equal stability.

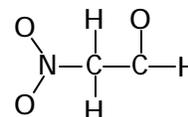
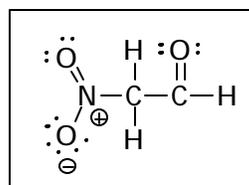
28. Which conformation of the compound shown above has 1,3-diaxial interactions?

(a) I, (b) II, (c) III, (d) None of the conformations has this sort of steric interaction.

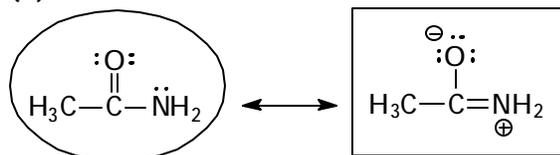
29. Which conformation of the compound shown above has torsional strain and bowsprit-flagpole interactions.
- (a) I, (b) II, (c) III, (d) Bogus question, dude! There's no such thing as torsional strain and bowsprit-flagpole interactions.
30. Conversion of one of the conformations to another involves
- (a) breaking  $\sigma$  bonds. (b) breaking  $\pi$  bonds. (c) rotation around  $\sigma$  bonds. (d) rotation around  $\pi$  bonds.

**Directions for Part II --- Answer the questions in the space provided. If there is insufficient space continue your answer on the back of the sheet but clearly indicate on the front of the sheet that you have done this.**

1. (a) Convert the skeleton structure on the right into a complete Lewis structure, clearly showing all bonds and unshared valence electrons.



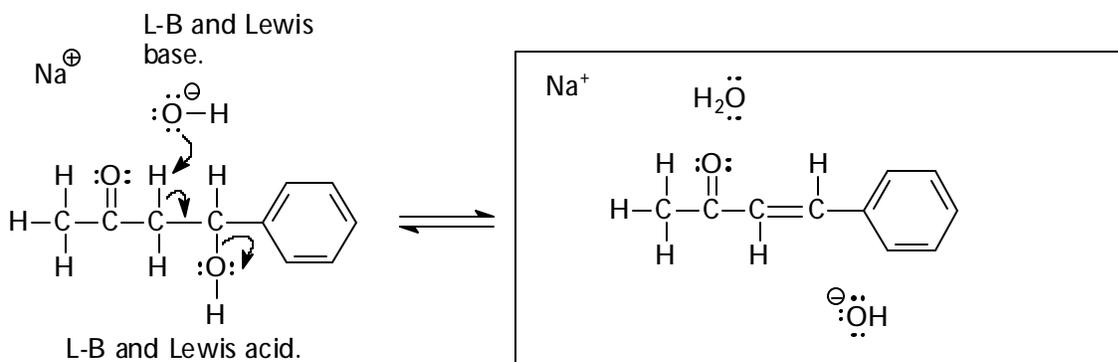
- (b) Draw a second resonance structure for the molecule shown below.



- (c) Circle the structure in part (b) that makes the greater contribution.

The structure on the left makes the greater contribution because it does not have charge separation.

2. (a) Shown below are the reactants in one step of the mechanism for the synthesis of dibenzalacetone from acetone and benzaldehyde. Draw the Lewis structures of the products. [The curved arrows have their usual meaning and should help you if you've forgotten the details of this mechanism.]

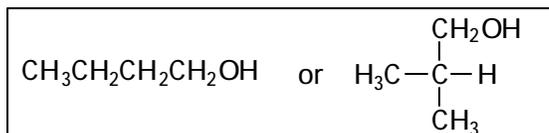


(b)

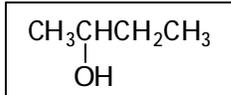
Label each of the two reactants above (ignore  $\text{Na}^+$  since it is a "spectator" ion), using as many of the following labels as is appropriate, in terms of their behavior in this reaction: Lewis acid, Lewis base, Lowry-Bronsted acid, Lowry-Bronsted base.

3. Using the molecular formula  $\text{C}_4\text{H}_{10}\text{O}$  draw a Lewis structure of

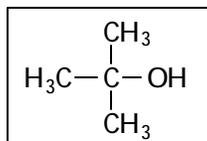
(a) a primary ( $1^\circ$ ) alcohol,



(b) a secondary ( $2^\circ$ ) alcohol, and



(c) a tertiary ( $3^\circ$ ) alcohol.



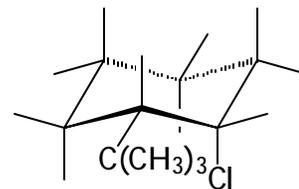
4. Consider *cis*-1-*tert*-butyl-2-chlorocyclohexane shown to the right.

(a) (i) Is the *tert*-butyl group axial or equatorial?

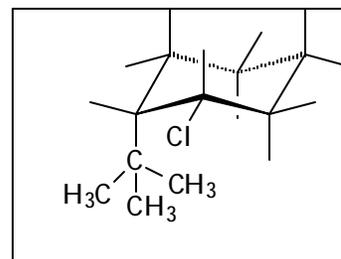
equatorial

(ii) Is the Cl axial or equatorial?

axial



(b) Using the skeleton to the right, draw another chair conformation (ring flip) of this molecule.



(c) Which conformation, (a) or (b), is more stable *and why*?

(a) is more stable because the 1,3-diaxial interactions of the *t*-butyl group in (b) are more severe than the 1,3-diaxial interactions of the Cl in (a) owing to the larger size of the *t*-butyl group.

(d) Using the skeleton to the right, draw *trans*-1-*tert*-butyl-2-chlorocyclohexane in its most stable chair conformation.

