Department of Chemistry
SUNY/Oneonta
Chem 101 - Introductory Chemistry: Organic
Examination #1 - February 25, 2004
ANSWERS

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. There is one "best" answer for each question so do not select more than one answer for a question; if you do, that question will be marked incorrect. Not answering a question and providing an incorrect answer are equivalent in terms of grading; therefore, it is logical to answer all of the questions.

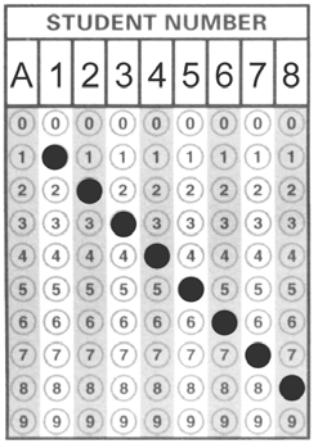
On the Test Scoring Answer Sheet, using a soft pencil, enter the following data (in the appropriate places) –

> Your name.
> Instructor's name.
> Your student number or Social Security number. **Since the first "digit" of your student number is a letter and not a number, you will not be able to darken a bubble in the first column if you use your student number. Fill in the bubbles in the remaining columns, making dark black circles. See the example below for a student with ID: A12345678.**
> Course number (30010101). Fill in the appropriate bubbles.
> The test number (01). Fill in the appropriate 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 are worth 3.33 points each.

You have 50 minutes. Good luck!



1. Of the elements below, which element attracts electrons to itself least strongly?
(a) carbon, (b) nitrogen, (c) oxygen, (d) sulfur
Carbon has the smallest electronegativity, as seen in the periodic table.

2. Which of the following atoms has 6 electrons in its valence shell?
(a) carbon, (b) nitrogen, (c) oxygen, (d) fluorine
The outermost shell having electrons is the valence shell. The periodic table lists 6 for oxygen.

3. A bond between a carbon atom and a sulfur atom is best described as
(a) non-polar covalent. (b) polar covalent. (c) ionic. (d) metallic.
The difference in electronegativities between carbon and sulfur is only 0.03. For anything less than about 0.5, the bond would be considered essentially non-polar.

4. For a compound to be electrically neutral (not carry a positive or negative charge) the number of _____ and _____ in the molecule must be the same.

(a) protons, neutrons, (b) neutrons, electrons, (c) electrons, protons,
(d) None of the previous answers is correct.
Electrons have a -1 charge and protons have a +1 charge.

5. Compounds that have the same molecular formula, but are different, are known as
(a) isomers. (b) isotopes. (c) allotropic forms. (d) isobars.
By definition.

6. In which allotropic form of carbon do 60 atoms of carbon form a sphere made up of pentagons and hexagons with carbon atoms at the apexes – just like a soccer ball?
(a) diamond, (b) graphite, (c) Buckministerfullerene, (d) sapphire

7. What is the maximum number of electrons that can be accommodated in the valence shell of an atom in the second row of the periodic table?

(a) 2, (b) 8, (c) 10, (d) 18

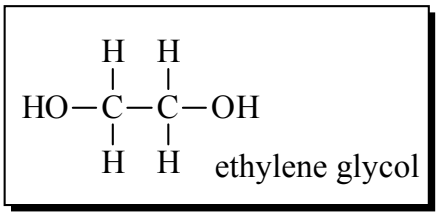
8. Which of the electronic "shells" (listed below) around the nucleus of an atom would be the smallest in size?
(a) #1, (b) #2, (c) #3, (d) Bogus question! This will depend on the atom under consideration.

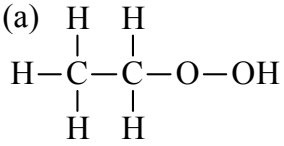
9. In modeling a molecule which of the following does the Lewis structure attempt to directly address?
I: which atoms are joined to each other by covalent bonds,
II: bond order *i.e.* whether a bond is a single, double or triple bond,
III: distribution of valence electrons on atoms as unshared electrons,
IV: the three-dimensional shape of the molecule

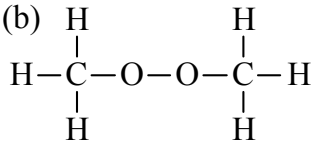
(a) I&II, (b) II&III, (c) III&IV, (d) I,II&III, (e) II,III&IV

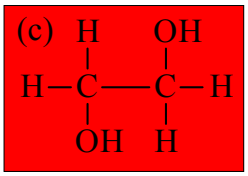
10. A chemical formula, like $C_{20}H_{42}O_2$, that tells you how many of each kind of atom are present in a molecule would be a(n)
(a) empirical formula. (b) molecular formula. (c) structural formula. (d) baby formula.
The empirical formula gives you the ratios of the numbers of each type of atom present, not the numbers themselves. So, the empirical formula for this compound would be $C_{10}H_{21}O$. Structural formulas show bonding.

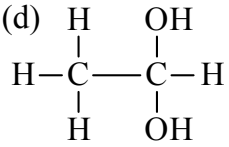
11. Which of the structures shown below is not a constitutional (structural) isomer of ethylene glycol?



(a) 

(b) 

(c) 

(d) 

For two molecules to be isomers they must have the same molecular formula but be different somehow. For two molecules to be structural isomers they must have the same molecular formula and the difference must be that the atoms are joined in a different way. All of the answers here have the same molecular formula. The compounds (a), (b), and (d) have different atomic connections and are structural isomers of ethylene glycol. Compound (c) has the same atomic connections as ethylene glycol; it is not an isomer of ethylene glycol – it is ethylene glycol.

12. If an isolated fluorine atom has a *total* of 10 electrons it is _____.

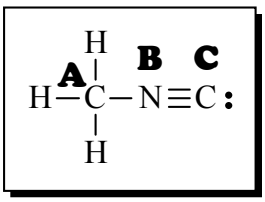
(a) a -1 ion, (b) electrically neutral, (c) a +1 ion, (d) a -2 ion,
(e) a +2 ion, (f) a -5 ion
See the periodic table. Fluorine has 9 protons (+9). If it has 10 electrons (-10), overall it will have a -1 charge.

13. A bond joining two atoms in a molecule will be covalent if _____.

(a) the sum of the electronegativities of the two atoms is less than 1.7, (b) the difference between the electronegativities of the two atoms is less than 1.7, (c) the sum of the electronegativities of the two atoms is greater than 1.7, (d) the difference between the electronegativities of the two atoms is greater than 1.7

14. Polar covalent bonds are characterized by
(a) electrons being equally shared between the atoms joined by the bond.
(b) protons being equally shared between the atoms joined by the bond.
(c) electrons being unequally shared between the atoms joined by the bond.
(d) protons being unequally shared between the atoms joined by the bond.
(e) one atom gaining one or more electrons lost by another.

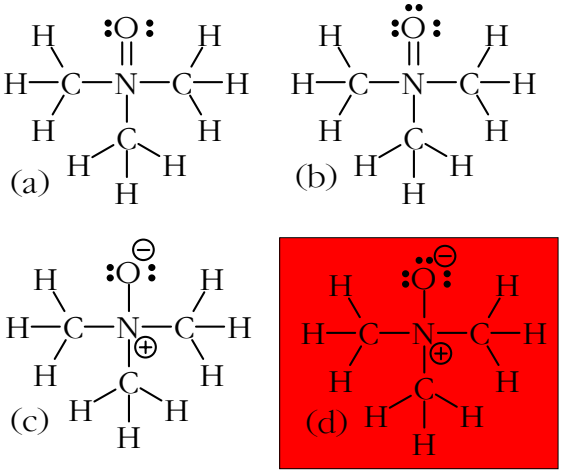
15. Calculate the formal charges, **A**, **B**, and **C**, on the carbon, nitrogen, and carbon in the structure to the right and select the correct answer.



(a) **A** = 0, **B** = +1, **C** = -1, (b) **A** = 0, **B** = -1, **C** = +1,
(c) **A** = +1, **B** = 0, **C** = -1, (d) **A** = +1, **B** = -1, **C** = 0,
(e) **A** = -1, **B** = +1, **C** = 0.

Formal charge = core charge - electron ownership.
For **A**: core charge = 4, electron ownership = 4 (one from each single bond).
For **B**: core charge = 5, electron ownership = 4 (one from the single bond; three from the triple bond).
For **C**: core charge = 4, electron ownership = 5 (three from the triple bond; two from the unshared pair).

16. Which of the Lewis structures shown to the right is correct? [Hint: One approach would be to start with the skeleton structure (atoms connected only by single bonds and no unshared electrons or formal charges shown) and work out the complete structure in the usual way.]

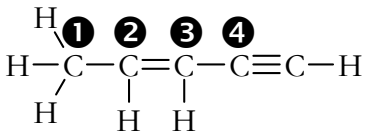


Short of going through the entire process of coming up with the structure *de novo*, we might note the following. Structures (a) and (b) show nitrogen with a valence shell occupancy of 10 electrons – impossible, 8 is the maximum. The formal charge on oxygen in (c) would be 6 (core charge) - 5 (electron ownership) = +1, not -1, as shown.

17. When we draw two or more resonance structures to represent a molecule we mean that
(a) the structure of the actual molecule oscillates back and forth between the structures we draw.
(b) some of the molecules of the compound look like one of the structures we have drawn and other molecules of the compound look like other structures we have drawn.
(c) the structure of the actual molecule is somewhere in between the structures we have drawn.

18. When we say that a certain molecule has a dipole moment, we mean that
(a) for just a moment the molecule is polar.
(b) the charge distribution in the molecule is permanently "lopsided" – one region of the molecule has partial positive charge and another has partial negative charge.
(c) for a moment the molecule has a north pole with Santa Claus and a south pole with penguins.
(d) Bogus question! There is no such thing as a dipole moment.

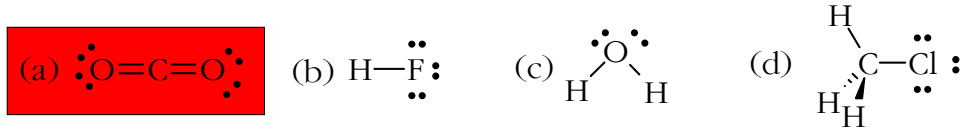
19. Select the answer (letter) from the table below which correctly indicates the geometries of carbon atoms 1-4 in the following compound:

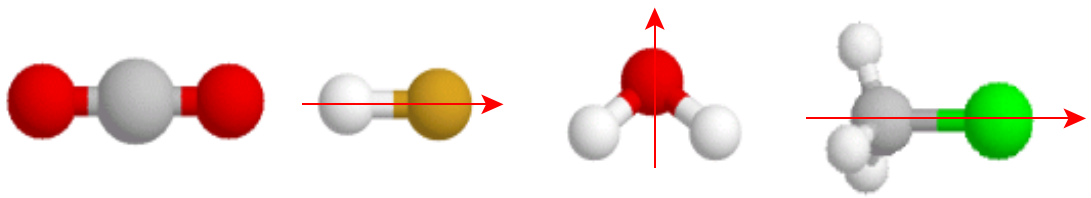


	❶	❷	❸	❹
(a)	linear	trigonal, planar	trigonal, planar	trigonal, planar
(b)	tetrahedral	linear	linear	tetrahedral
(c)	linear	linear	tetrahedral	tetrahedral
(d)	tetrahedral	trigonal, planar	trigonal, planar	linear
(e)	tetrahedral	tetrahedral	linear	linear

If there are 4 electron "groups" (unshared pair of electrons or bond, whether single or multiple) around an atom it is tetrahedral. If there are 3 electron groups it is trigonal/planar. If there are 2 electron groups it is linear.

20. Which of the following compounds would be non-polar, *i.e.* have a dipole moment of 0? [Molecular geometries are shown below the Lewis structures.]





To be polar one side of the molecule must have a partial negative charge and the other side must have a partial positive charge. This usually arises from differences in

electronegativities among the atoms that are joined to each other. In all four of the molecules above there are electronegativity differences. In (b), (c) and (d) these differences make one side of the molecule more negative than the other. I (a) this does not happen because of the linearity and symmetry of the molecule.

21. If molecules did not attract each other through non-bonded interactions, molecular materials would all be

(a) gasses. (b) liquids. (c) solids. (d) Bogus question! Non-bonded interactions have nothing to do with the states of matter.
If there were no "adhesive" forces between molecules they would fly apart like billiard balls as they struck each other owing to their motion which is the manifestation of thermal energy. This is the nature of a gas – the molecules are apart from each other and only interact upon collision. In liquids and solids the molecules are in intimate contact with neighbors all the time (owing to the non-bonded interactions).

22. Which of the non-bonded molecular interactions listed below is the weakest?

(a) Hydrogen bonding. (b) Dipole-dipole interactions. (c) London forces.
(d) Paris forces.

23. Which type of non-bonded interaction would be most important for ethyl alcohol, CH_3-CH_2-O-H?

(a) Hydrogen bonding. (b) Dipole-dipole interactions. (c) London forces.
(d) Paris forces.
Hydrogen bonding is the strongest of the non-bonded intermolecular forces.

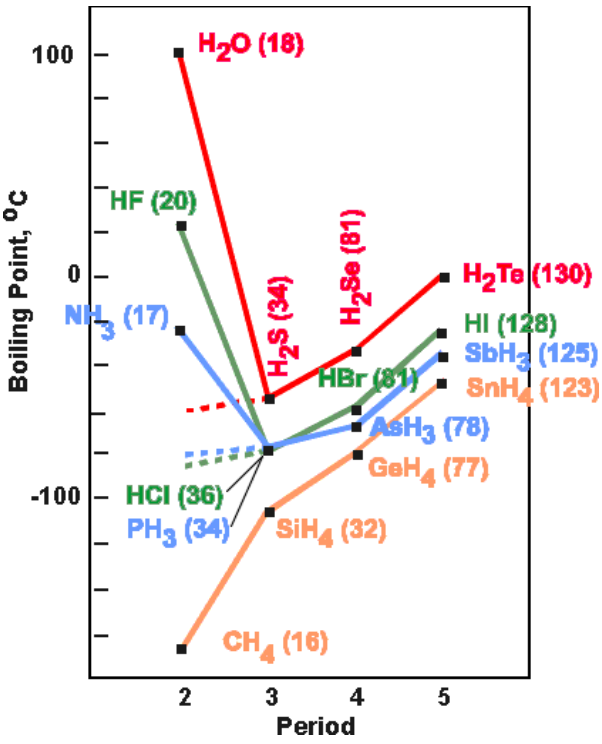
24. Which of the following statements is (are) true with regard to 1-pentanol, $CH_3CH_2CH_2CH_2CH_2$-OH, and ethyl propyl ether, CH_3CH_2-O-$CH_2CH_2CH_3$?

I: They are isomers. II: When in the liquid state they are both associated liquids.
III: The boiling point of 1-pentanol is higher than that of ethyl propyl ether.
IV: Neither has a dipole moment.

(a) I, (b) II, (c) III, (d) IV, (e) I & II, (f) II & III, (g) III & IV, (h) I & III
I: The have the same molecular formula, $C_5H_{12}O$, but are different. II: Pentanol molecules hydrogen bond to each other (associated liquid) but the ether molecules do not. For hydrogen bonding to occur there must be a hydrogen on a N, O, or F. III: The two compounds have the same molecular weight (they have the same molecular formula) so their weight is not an issue here. However, because of the hydrogen bonding in pentanol, which does not exist in the ether, pentanol is higher boiling. IV: They both have dipole moments.

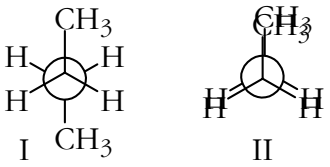
25. The purpose of the graph on the right is to demonstrate the effect of _____ and _____ on boiling point.

(a) molecular mass/hydrogen bonding,
(b) molecular mass/dipole-dipole interactions,
(c) hydrogen bonding/electronegativity,
(d) atomic shape/electronegativity



26. Two conformations of butane are shown to the right. These conformations are shown in the type of drawing we call a

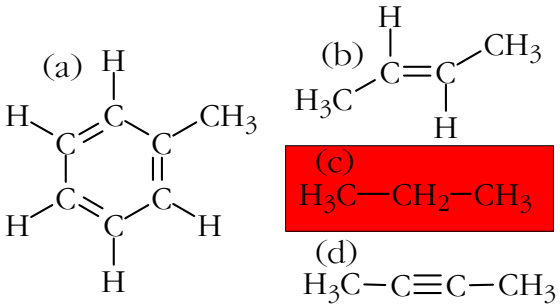
(a) sawhorse projection. (b) Newman projection.
(c) stereo projection. (d) perspective projection.



27. Two conformations of butane around the C2-C3 bond are shown in question #26. Select the correct statement below.

(a) I is called antiperiplanar; II is called synperiplanar. II is less stable than I because II has torsional and steric strain.
(b) I is called synperiplanar; II is called antiperiplanar. II is less stable than I because II has torsional and steric strain.
(c) I is called antiperiplanar; II is called synperiplanar. I is less stable than II because I has torsional and steric strain.
(d) I is called synperiplanar; II is called antiperiplanar. I is less stable than II because I has torsional and steric strain.

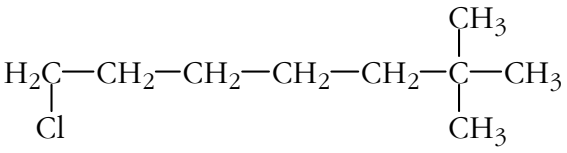
28. Which of the compounds shown to the right is an alkane?



29. The most common reaction type for alkanes to undergo is

(a) polymerization, (b) halogenation, (c) combustion, (d) addition

30. Select the correct IUPAC name for compound shown to the right.



(a) 2,2-dimethyl-7-chloroheptane,
(b) 1,1,1-trimethyl-6-chlorohexane
(c) 1-chloro-6,6,6-trimethylhexane,
(d) 1-chloro-6,6-dimethylheptane

The longest chain has 7 carbons, so the parent name is heptane. If we number the chain from the left the first substituent (Cl) occurs on carbon-1. If we number the chain from the right the first substituent (actually two substituents in this case, the methyl groups) occurs on carbon-2. Since 1 is smaller than 2, we number from the left.