# Exam 3

Chem 111, Section 2 (10:10 am) Fall 1998

This test is closed book, closed notes, and closed neighbors. A periodic table and other useful information is available at the end of the test. When told to begin, read through the entire exam, and decide which questions you can answer quickly. After you have answered those questions, return to the more involved questions and answer them.

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By signing below, I agree to abide by the University rules and regulations regarding honesty on exams. I understand that I am not to look at others' exams nor allow others to view mine. I hereby state that all answers on the answer sheet are my own.

I understand that Professor Martin considers academic honesty to be central to the goals of the University and that dishonest behavior will dealt with very seriously.

Printed Name: _____

Signature: _____

**As soon as you have your OpScan (answer) sheet:**

1) Place your name where indicated.

2) Place your student ID number where indicated, starting at column **A**.

3) Place a "**1**" in column "K" of the special codes section.

Fill in the bubbles corresponding to the above.

**Failure to correctly enter any of the above 3 items will result in the deduction of 5 points from your exam.**

**Tear this page off and return with your completed answer sheet**.

**You should take the rest of your exam home with you because**

As a homework assignment, you may earn up to 10% of the points you missed on this exam. Details are at the end of this exam.

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**Proceed immediately to the end of this exam and write your exam code on your OpScan Sheet.**

1. (5 points) Schroedinger's model of the hydrogen atom revolutionized our understanding of atomic structure because:

   (a) the wave functions which result from the solution are related to the probability of finding an electron at a given location in space
   (b) it treated electrons as waves
   (c) the solution of the equation he set up resulted naturally in the conclusion that the energy of the electron is quantized
   (d) it introduces the concept of "electron density" rather than the electron's unique position
   (e) all of the above

**(Questions 2-6)** Just as we need 3 coordinates (x,y,z) to specify the position of a particle in space, Schroedinger's equation requires 3 "quantum numbers" n, *l*, m to define an energy state and orbital which the electron can "occupy."

2. (3 points) These quantum numbers are called: n, principal quantum number; *l*, angular momentum quantum number; $m_l$, magnetic quantum number.

   (a) False (b) True

3. (3 points) Analogous to the coordinates x,y,z, n, *l*, m can each take on any real integer value.

   (a) False (b) True

4. (3 points) The value of n indicates the "shell" the electron is in, *l* the subshell and $m_l$ the specific orbital.

   (a) False (b) True

5. (3 points) The orbitals have shapes, for example "s" orbitals can be characterized as cloverleaves (i.e., 4 lobes in a plane); "p" orbitals are spherical, and "d" orbitals have two spherical lobes looking approximately like a 3-dimensional figure 8.

   (a) False (b) True

6. (3 points) The Pauli Exclusion Principle states that no two electrons could have the same values of the principal quantum number n, and the angular momentum quantum number *l*.

   (a) False (b) True

7. (5 points) Which of the following atoms would be most paramagnetic: (hint -- draw a "box" diagram):

   a) Li $1s^2\ 2s^2$
   b) N $1s^2\ 2s^2\ 2p^3$
   c) Ne $1s^2\ 2s^2\ 2p^6$
   d) B $1s^2\ 2s^2\ 2p^1$
   e) Si $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

8. (5 points) Electrons are attracted to protons in the nucleus. However, electrons in shells closer to the nucleus "shield" electrons in outer shells from the attractions of the protons. That is, the electrons in outer shells "see" or "feel" an effective positive charge less than the full nuclear charge. Which electron "feels" the <u>least</u> nuclear charge?

   a) a 2p electron in carbon Z = 6 C $1s^2\ 2s^2\ 2p^2$ b) a 2p electron in neon Z = 10 Ne $1s^2\ 2s^2\ 2p^6$
   c) a 2p electron in phosphorus Z = 15 P $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
   d) a 2s electron in oxygen Z = 8 O $1s^2\ 2s^2\ 2p^4$
   e) a 2s electron in lithium Z = 3 Li $1s^2\ 2s^1$

9. (3 points) Hund's rule states that electrons want to be paired. Thus, the most stable electron configuration is to have the most paired electrons. For example, carbon has 6 electrons, C $1s^2\ 2s^2\ 2p^2$. According to Hund's rule, the last two electrons would go into the same 2p orbital, one with spin up, and one with spin down.

   (a) False (b) True

**(Questions 10-13)** We can use the concept of electron screening to help us understand and predict trends in ionization energies. We would expect:

10. (3 points) The first ionization energy of Li ($Li \rightarrow Li^+ + e^-$) is less than that of Be ($Be \rightarrow Be^+ + e^-$).

    (a) False (b) True

11. (3 points) The second ionization energy of Li ($Li^+ \rightarrow Li^{2+} + e^-$) is less than that of Be ($Be^+ \rightarrow Be^{2+}$).

    (a) False (b) True

12. (3 points) The ionization energy of Ne ($Ne \rightarrow Ne^+ + e^-$) is greater than the ionization energy of oxygen ($O \rightarrow O^+ + e^-$).

(a) False (b) True

13. (3 points) The second ionization energy of Na ($Na^+ \rightarrow Na^{2+} + e^-$) is less than the ionization energy of Ne ($Ne \rightarrow Ne^+ + e^-$).

(a) False (b) True

14. (5 points) Which is the correct ordering of increasing radii (smallest < ... < largest)?

(a) $Ne < O^{2-} < N^{3-} < F^-$ (b) $N^{3-} < O^{2-} < F^- < Ne$ (c) $Ne < F^- < O^{2-} < N^{3-}$

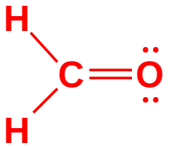
(d) $F^- < O^{2-} < N^{3-} < Ne$ (e) $F^- < N^{3-} < O^{2-} < Ne$

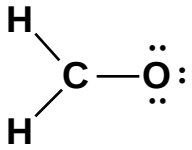
15. (5 points) The 3p electrons on P (phosphorous) "see" an effective nuclear charge of:

(a) 5 (b) 15 (c) 31 (d) 6 (e) 3

16. (5 points) What is wrong with the Lewis structure for $CH_2O$, shown below?

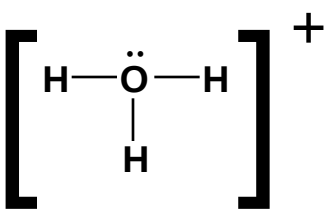
(a) oxygen has more than an octet
(b) oxygen's formal charge is too positive
(c) carbon's formal charge is too negative
(d) carbon does not have an octet
(e) b, c, and d





17. (5 points) What is wrong with the Lewis structure for $H_3O^+$, shown below?

(a) oxygen does not have an octet
(b) oxygen's formal charge is too positive
(c) there are too few electrons overall
(d) oxygen's formal charge is too negative
(e) nothing is wrong; it is a perfect Lewis structure



18. (5 points) In the molecule NOCl, what is the bond order of the NO bond?

(a) 0 (b) 1 (c) 2 (d) 3 (e) 4

19. (5 points) Predict the enthalpy $\Delta H_{rxn}$ of the following reaction:

$$2\ CH_3{-}O{-}CH_3 \rightarrow O_2 + 2\ CH_3{-}CH_3$$

**Bond Energies**

$D_{C-H} = 413$ kJ/mol
$D_{C-O} = 358$ kJ/mol
$D_{O-O} = 146$ kJ/mol
$D_{O=O} = 498$ kJ/mol
$D_{C-C} = 346$ kJ/mol

(a) –128 kJ/mol (b) +224 kJ/mol (c) –486 kJ/mol
(d) –1,202 kJ/mol (e) +1,202 kJ/mol

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20. (5 points) What is the (molecular) geometry for the chlorate anion, $ClO_3^-$ ?

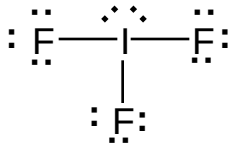
(a) linear (b) bent (c) tetrahedral (d) trigonal pyramid (e) triangular-planar

21. (5 points) What is the molecular geometry of $AsCl_5$ (As is at the center)?

(a) T-shaped (b) octahedral (c) trigonal pyramid
(d) tetrahedral (e) triangular-bipyramidal

22. (5 points) What is the molecular geometry of $IF_3$ (I is at the center)?

(a) T-shaped (b) trigonal planar (c) trigonal pyramid
(d) tetrahedral (e) triangular-bipyramidal



23. (5 points) Which molecule below is ***not*** polar?

(a) $H_2O$ (b) $NH_3$ (c) ClF (d) $CCl_4$
(e) they are all polar

24. (5 points) In which molecule below are the bonds ***most*** polar?

(a) $H_2O$ (b) $NH_3$ (c) $CH_4$ (d) $H_2$ (e) $O_2$

You have version **1** of the exam. Place **1** in column **K** of your answer sheet.

**Remember:**

As a homework assignment, you may earn up to 10% of the points you missed on this exam (eg., if you scored a 60 on the exam, you can earn up to an extra 4 points), by doing the following:

1) Pick up an extra Op-Scan sheet when you turn in your exam.

2) Work through all of the problems at home (consultation with others is OK, but you should answer the questions yourself). Answer all of the questions. Turn in the Op-Scan sheet in class on Monday, November 23 (***no later!***).

Your revised exam will be scored and credit applied proportional to the total number of questions answered correctly. Complete the exam exactly as you did previously (except with all correct answers, of course!).

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Answers and scores for the original exam will be available by November 23, after the deadline for turning exam re-takes in. Check our home page.