

CHEMISTRY 101
Hour Exam III
April 27, 2017
Dr. D. DeCoste

Name _____

Signature _____

T.A. _____

This exam contains 17 questions on 6 numbered pages. Check now to make sure you have a complete exam. You have one hour and thirty minutes to complete the exam. Determine the best answer to the first 15 questions and enter these on the special answer sheet. Also, circle your responses in this exam booklet. Show all of your work and provide complete answers to questions 16 and 17.

No calculators are allowed on this exam.

1-15	(30 pts.)	_____
16	(12 pts.)	_____
17	(18 pts.)	_____
Total	(60 pts)	_____

Geometries (alphabetical order)

Linear
Octahedral
Tetrahedral
Trigonal bipyramid
Trigonal planar

Shapes (alphabetical order)

Bent
Linear
Octahedral
See-saw
Square planar
Square pyramid
Tetrahedral
Trigonal bipyramid
Trigonal planar
Trigonal pyramid
T-shape

1. Which of the following statements is **false**?
- a) The freezing of water is an endothermic process.
 - b) Ionization energies for atoms are endothermic.
 - c) "Lower in energy" also means "more stable".
 - d) The ground state is the lowest energy state.
 - e) In an exothermic chemical reaction, the products are more stable than the reactants.
2. Which of the following describes an exothermic process/reaction?
- a) Water condenses on the outside of a glass of lemonade in the summertime.
 - b) Removing the second electron from a Group 2 atom (alkaline earth metal).
 - c) The reactants are lower in energy than the products.
 - d) The electron moves from the $n = 2$ to the $n = 3$ energy level in the hydrogen atom.
 - e) An electron goes from the ground state to an excited state.
3. How many of the following support the idea that energy levels in an atom are quantized?
- I. An "electric pickle" glows orange.
 - II. A colorful fireworks display.
 - III. Flame tests can be used to identify metal ions.
 - IV. The hydrogen emission spectrum is a line spectrum.
- a) 0 b) 1 c) 2 d) 3 e) 4
4. By considering electrons to have wave properties, we can better explain
- a) the existence of ionic bonds.
 - b) the idea of orbitals as probability distributions.
 - c) why water is a bent molecule.
 - d) the need for resonance structures when drawing some Lewis structures.
 - e) the relationship between boiling points and intermolecular forces.
5. Which of the following statements (a-c) is **false**?
- a) The ground state electron configuration for the most stable ion of sodium in a compound is $1s^2 2s^2 2p^6$.
 - b) The ground state electron configuration for the valence electrons of the halogens (such as fluorine and chlorine) is $ns^2 np^5$.
 - c) An electron configuration for an excited state of the carbon atom could be $1s^2 2s^2 2p^3$.
 - d) At least two of the above statements (a-c) are false.
 - e) All of the above statements (a-c) are true.

6. In order to remove an electron from the potassium atom, energy is _____, and in order to remove an electron from a chlorine atom, energy is _____.
- a) required, released
 - b) released, required
 - c) released, released
 - d) required, required
7. Many decades ago, a chemist at the University of Illinois reported the discovery of a new element and named it Illinium. Unfortunately, he could not substantiate its existence and many years later another chemist claimed it and it is now named Promethium, Pm. What is the expected ground state electron configuration for the element briefly known as Illinium?
- a) [Xe] $6s^2 5d^{10} 4f^4$
 - b) [Xe] $6s^2 5d^1 2f^4$
 - c) [Xe] $6s^2 5d^1 4f^4$
 - d) [Xe] $6s^2 6d^1 5f^4$
 - e) [Xe] $6s^2 6d^1 6f^4$
8. How many of the following statements is/are **true**?
- I. Elements in the same column of the periodic table generally have the same number of valence electrons.
 - II. The 3s orbital and 1s orbital have the same shape.
 - III. The expected ground state electron configurations for species in an isoelectronic series are the same.
 - IV. The most stable chlorine ion in a compound atom has 8 valence electrons.
- a) 0 b) 1 c) 2 d) 3 e) 4
9. How many of the following expected ground state electron configurations is/are correct?
- I. Se: [Ar] $4s^2 3d^{10} 4p^4$
 - II. Po^{2-} : [Xe] $6s^2 4f^{14} 5d^{10} 6p^6$
 - III. Mg^{2+} : $1s^2 2s^2 2p^6$
 - IV. U: [Rn] $7s^2 6d^1 5f^3$
- a) 0 b) 1 c) 2 d) 3 e) 4
10. Which of the following statements is **false**?
- a) The smaller the difference in electronegativity values between bonding atoms, the greater the covalent character of the bond.
 - b) The oxygen atom is more electronegative than the phosphorus atom.
 - c) It is possible for a molecule with polar bonds to have no overall dipole moment.
 - d) In general, larger atoms have larger electronegativity values.
 - e) For two nonpolar substances, the one with the larger molecules tends to have the higher boiling point.

11. What type(s) of intermolecular force(s) is/are exhibited by methane (CH₄)?

- a) hydrogen bonding and London dispersion forces
- b) London dispersion forces
- c) hydrogen bonding
- d) dipole-dipole and London dispersion forces
- e) dipole-dipole

12. Which of the following species exhibits resonance?

- a) NH₄⁺
- b) OCl₂
- c) NO₂⁻
- b) CH₄
- e) At least two of the above species (a-d) exhibit resonance.

13-15. For each of the following molecules, choose the correct molecular geometry, shape, and polarity.

GEOMETRY SHAPE POLARITY

13. Sulfur tetrafluoride (sulfur is the central atom)

- | | | | |
|----|--------------------|---------------|-----------|
| a) | trigonal bipyramid | see-saw | polar |
| b) | tetrahedral | tetrahedral | polar |
| c) | tetrahedral | tetrahedral | non-polar |
| d) | octahedral | square planar | non-polar |
| e) | trigonal bipyramid | square planar | non-polar |

14. Sulfur dioxide (sulfur is the central atom)

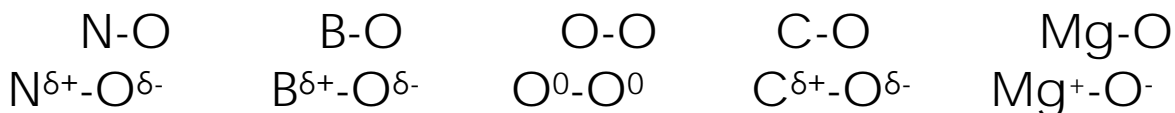
- | | | | |
|--|-----------------|--------|-----------|
| a) | trigonal planar | bent | non-polar |
| <input checked="" type="checkbox"/> b) | trigonal planar | bent | polar |
| c) | linear | linear | non-polar |
| d) | tetrahedral | bent | polar |
| e) | linear | linear | polar |

15. Nitrogen triiodide (nitrogen is the central atom)

- | | | | |
|--|-----------------|------------------|-----------|
| a) | trigonal planar | trigonal planar | non-polar |
| b) | tetrahedral | trigonal planar | non-polar |
| c) | tetrahedral | tetrahedral | non-polar |
| <input checked="" type="checkbox"/> d) | tetrahedral | trigonal pyramid | polar |
| e) | trigonal planar | bent | polar |

16. This question deals with the concept of bond polarity. Please defend your answer when asked.

- a. Consider the following bonds. Label each atom in each bond with either $\delta+$, $\delta-$, +, -, or 0 (for no charge, partial or otherwise).



[Accept +2 and -2 as well]

- b. Could any of the bonds above be considered perfectly covalent? If so, list which one(s) and defend your answer. If not, why not?

The O-O bond is perfectly covalent. This is because the bond is between identical atoms so the electronegativity difference is zero.

- c. Could any of the bonds above be considered ionic? If so, list which one(s) and defend your answer. If not, why not?

The Mg-O bond is ionic. This is because the bond is between a metal and a non-metal. The oxygen atom will essentially take two electrons from the magnesium atom resulting in the formation of ions.

- d. Of the remaining bonds (not listed in "b" or "c" above), rank them from most polar to least polar and defend your answer.

$B-O > C-O > N-O$. All of these atoms are in the same row of the periodic table. The further the atoms are from each other, then, the greater the electronegativity difference and the more polar the bond.

17. In this problem you will rank molecules based on their boiling points and explain.

a. Fill in the following table.

	Ethane (C ₂ H ₆)	Methanol (CH ₃ OH)	Methane (CH ₄)	Formaldehyde (H ₂ CO)
Lewis structure	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\ddot{\text{O}}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\ddot{\text{O}} \\ \diagup \\ \text{H} \end{array}$
Polar or non-polar?	NON-POLAR	POLAR	NON-POLAR	POLAR
Strongest IMF	LONDON DISPERSION	HYDROGEN BONDING	LONDON DISPERSION	DIPOLE-DIPOLE

b. Fill in the appropriate names in the table below.

Boiling Point (at 1.00 atm)	Name of molecule
-161°C	METHANE
-89°C	ETHANE
-21°C	FORMALDEHYDE
65°C	METHANOL

c. **Explain how** you matched the boiling points and the names in part b. **Use your answers** in the table in part 'a' to **support** your matches, **and discuss shapes of the molecules, intermolecular forces, and boiling point, and define your terms.**

See textbook and lecture notes.

17c. (con't). If you need more space for your answer to 17c, please use the space below.