

CHEMISTRY 101  
Hour Exam III  
April 26, 2018  
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	(14 pts.)	_____
17	(16 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 is lowest in energy?
- A valence electron of a lithium (Li) atom.
  - A valence electron of a chlorine (Cl) atom.
  - A valence electron of a bromine (Br) atom.
  - A valence electron of an iodine (I) atom.
  - All of the above (a-d) are equally low in energy.
2. Across a row (left to right) on the periodic table, atomic radii generally \_\_\_\_\_, ionization energies generally \_\_\_\_\_, and electronegativity values generally \_\_\_\_\_.

Down a column (group) on the periodic table, atomic radii generally \_\_\_\_\_, ionization energies generally \_\_\_\_\_, and electronegativity values generally \_\_\_\_\_.

**Across a row**

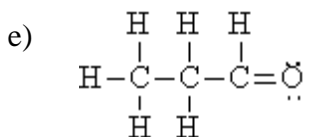
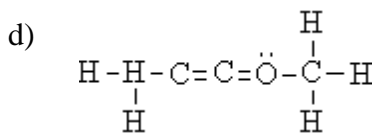
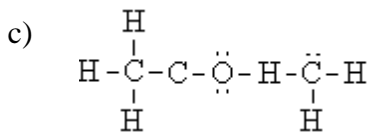
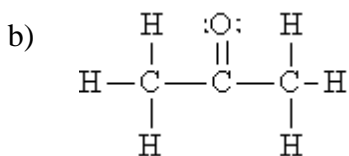
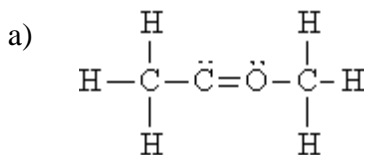
- decrease, decrease, decrease
- increase, increase, increase
- increase, decrease, decrease
- decrease, increase, increase
- decrease, increase, decrease

**Down a column**

- increase, increase, increase
- decrease, decrease, decrease
- decrease, increase, increase
- increase, decrease, decrease
- increase, decrease, increase

3. Which of the following is **true** concerning trends on the periodic table?
- In general, smaller atoms have larger ionization energies, and smaller electronegativity values.
  - In general, smaller atoms have smaller ionization energies, and smaller electronegativity values.
  - In general, smaller atoms have smaller ionization energies, and larger electronegativity values.
  - In general, smaller atoms have larger ionization energies, and larger electronegativity values.
  - There are no general trends among atomic radius, ionization energy, and electronegativity.
4. Which of the following is **true** about an isoelectronic series?
- The most positively charged species has the largest atomic radius, and the most negatively charged species has the smallest atomic radius.
  - The noble gas has the largest atomic radius, and the most negatively charged species has the smallest atomic radius.
  - The noble gas has the largest atomic radius, and the most positively charged species has the smallest atomic radius.
  - The most negatively charged species has the largest atomic radius, and the most positively charged species has the smallest atomic radius.
  - All of the species in an isoelectronic series have the same atomic radius.

5. Which of the following statements is **false**?
- When the difference in electronegativity between two atoms is very large, the bond most likely to form between the two atoms is an ionic bond.
  - Covalent bonding results in the sharing of valence electrons between two atoms.
  - The valence electrons in a polar bond are found nearer (on the average) to the more electronegative atom in the bond.
  - VSEPR theory states that the central atom in a molecule has the bonded atoms and lone pairs arranged so to minimize electron-electron repulsions.
  - If a molecule has polar bonds it is a polar molecule.
6. Which of the following species exhibits resonance?
- $\text{NO}_2^-$
  - $\text{NH}_4^+$
  - $\text{CH}_4$
  - $\text{OF}_2$
  - At least two of the above species (a-d) exhibit resonance.
7. Select the best Lewis structure for acetone,  $\text{CH}_3\text{COCH}_3$ .



8. How many resonance structures does ozone ( $O_3$ ) have?
- a) 0            b) 1            c) 2            d) 3            e) 4
9. Which of the following statements is **false**?
- a) A molecule can have both an octahedral geometry and a bent shape.  
b) A molecule can have both a trigonal bipyramid geometry and a linear shape.  
c) A molecule can have both a tetrahedral geometry and a trigonal pyramid shape.  
d) A molecule can have both a trigonal planar geometry and a trigonal planar shape.  
e) A molecule can have both a tetrahedral geometry and a bent shape.
10. How many of the following molecules are polar?
- |  |        |         |        |         |
|--|--------|---------|--------|---------|
|  | $SF_4$ | $XeF_4$ | $CF_4$ | $SiF_4$ |
|--|--------|---------|--------|---------|
- a) 0            b) 1            c) 2            d) 3            e) 4
11. Which of the following correctly pairs the molecule with the strongest intermolecular attraction?
- |                           |                         |                          |
|---------------------------|-------------------------|--------------------------|
| <b><math>Li_2O</math></b> | <b><math>F_2</math></b> | <b><math>SO_2</math></b> |
| a) dipole-dipole          | London dispersion       | dipole-dipole            |
| b) dipole-dipole          | dipole-dipole           | dipole-dipole            |
| c) ion-ion                | London dispersion       | dipole-dipole            |
| d) dipole-dipole          | London dispersion       | ion-ion                  |
| e) ion-ion                | dipole-dipole           | London-dispersion        |
12. Hydrocarbons consist only of hydrogen and carbon atoms. Some long-chained hydrocarbons (with many carbons and hydrogens) are solids at room conditions. Which of the following is the best explanation for this?
- a) Because of so many hydrogen atoms, there is a great deal of hydrogen bonding, which is a strong form of dipole-dipole interactions.  
b) Hydrocarbons exert ion-ion interactions, and these interactions are the strongest of the intermolecular forces. Thus, the molecules stick together with a great deal of force.  
c) Hydrocarbons only exert weak London dispersion forces, but because the molecules are long-chained, there are many of these interactions.  
d) Hydrocarbon molecules, due to their shape, are polar, thus the intermolecular forces are dipole-dipole interactions. These interactions are quite strong and allow the molecules to stick together readily.  
e) No hydrocarbons are solids at room conditions.

13. Methane ( $\text{CH}_4$ ) is a gas, but carbon tetrachloride ( $\text{CCl}_4$ ) is a liquid at room conditions. Which of the following explains this phenomenon?
- a)  $\text{CCl}_4$  is a polar molecule and  $\text{CH}_4$  is not.
  - b)  $\text{CCl}_4$  and  $\text{CH}_4$  have different geometries and shapes.
  - c)  $\text{CH}_4$  exhibits hydrogen bonding and  $\text{CCl}_4$  does not.
  - d) Cl is more electronegative than H.
  - e) None of these (a-d) adequately explain the different phases of methane and carbon tetrachloride.
14. Which of the following is the correct ordering of boiling points for  $\text{H}_2\text{O}$ ,  $\text{C}_2\text{H}_6$ , and  $\text{H}_2\text{CO}$  (from lowest to highest)?
- a)  $\text{H}_2\text{O} < \text{C}_2\text{H}_6 < \text{H}_2\text{CO}$
  - b)  $\text{C}_2\text{H}_6 < \text{H}_2\text{CO} < \text{H}_2\text{O}$
  - c)  $\text{H}_2\text{CO} < \text{H}_2\text{O} < \text{C}_2\text{H}_6$
  - d)  $\text{H}_2\text{O} < \text{H}_2\text{CO} < \text{C}_2\text{H}_6$
  - e)  $\text{C}_2\text{H}_6 < \text{H}_2\text{O} < \text{H}_2\text{CO}$
15. Which of the following has the **lowest** boiling point?
- a)  $\text{N}_2$       b) HF      c)  $\text{NH}_3$       d)  $\text{Na}_2\text{S}$       e)  $\text{H}_2$

16. a. Label each as endothermic or exothermic and provide a brief explanation.

- i. You drop a racquetball into liquid nitrogen. From the perspective of the racquetball, is the process endothermic or exothermic? Defend your answer.
  
- ii. You add ammonium nitrate solid to water and measure the temperature of the solution. The temperature of the solution decreases. Is the dissolving of ammonium nitrate endothermic or exothermic? Defend your answer.
  
- iii. A hydrogen gas emission tube glows a purplish color. Is the emission of “purple light” due to an endothermic or exothermic process? Defend your answer.

b. Write the expected electron configuration for each of the following species. **Write the complete electron configuration for ii, iii, and iv.**

- i. The ground state for zirconium (Zr). Use the Noble gas shorthand form.
  
- ii. The ground state for sulfur (S).
  
- iii. The most stable ion for magnesium (Mg) in an ionic compound.
  
- iv. An excited state for aluminum (Al).

17. Fill in the following table. Do not worry about resonance structures when drawing Lewis structures but do include all lone pairs of electrons. The first atom is the central atom in each case. See the front of the exam for names of the geometries and shapes.

<b>Formula</b>	<b>Lewis structure</b>	<b>Geometry around central atom</b>	<b>Shape around central atom</b>	<b>Polarity (yes or no)</b>
<b>SCl<sub>4</sub></b>				
<b>CCl<sub>4</sub></b>				
<b>XeCl<sub>4</sub></b>				
<b>BCl<sub>3</sub></b>				