

CHEMISTRY 101
Hour Exam III
December 3, 2015
Adams/Trinh

Name _____

Signature _____

Section _____

"Zeal without knowledge is fire without light."

-Thomas Henry Huxley-

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.

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

- Based on the ground state electron configuration of iodine (I), how many electrons occupy the p and d orbitals?
 - 23
 - 33
 - 43
 - 44
 - 53
- The electrons involved in a C–F bond could be considered
 - closer to C because carbon has a larger radius and thus exerts greater control over the shared electrons.
 - closer to F because fluorine has a higher electronegativity than carbon.
 - closer to C because carbon has a lower ionization energy than fluorine.
 - an inadequate model since the bond is ionic.
 - centrally located directly between the C and F since the electrons are shared.
- Which of the following ions has the Lewis structure: $\left[\begin{array}{c} \cdot\cdot \\ \cdot\cdot \\ \cdot\cdot \\ \cdot\cdot \end{array} \text{X} - \begin{array}{c} \cdot\cdot \\ \cdot\cdot \\ \cdot\cdot \\ \cdot\cdot \end{array} \text{X} : \right]^{2-}$
 - B_2^{2-}
 - C_2^{2-}
 - N_2^{2-}
 - O_2^{2-}
 - F_2^{2-}
- Consider the following order: $\text{Li} < \text{N} < \text{F}$
For which of the properties below does the order show the correct trend?
 - size
 - electronegativity
 - metallic character
 - number of unpaired electrons
 - More than one of the above properties (a-d) shows the correct trend.
- Chemicals placed in a microwave oven and exposed to microwave radiation can increase in temperature if they possess a net dipole moment. How many of the following molecules can get hot in an operating microwave oven?
 $\text{CCl}_4, \text{PF}_5, \text{HCl}, \text{BH}_3, \text{CO}_2$
 - 1
 - 2
 - 3
 - 4
 - 5
- How many of the following processes are exothermic? (The system is underlined.)
 - combustion of methane (e.g. Bunsen burner)
 - melting of ice
 - evaporation of acetone (e.g. finger nail polish remover)
 - steam condensing on a cold surface
 - 0
 - 1
 - 2
 - 3
 - 4

7. Element X, which has a valence shell configuration of ns^2np^4 , was isolated in a laboratory. Which of the following statements are **true** concerning element X?
- I. Element X has chemical properties similar to those of the halogens.
 - II. Element X has six valence electrons.
 - III. When element X is reacted with calcium, the compound formed would most likely have the formula Ca_2X .
 - IV. Element X needs to gain two electrons to attain a noble gas electron configuration.
- a) II and IV
b) III and IV
c) II, III, and IV
d) I and III
e) I and IV
8. Formaldehyde has the formula CH_2O where C is the central atom. The molecules in a sample of formaldehyde are attracted to each other by a combination of:
- a) dipole-dipole forces and ionic forces.
 - b) hydrogen bonding and dipole-dipole forces.
 - c) ionic forces and hydrogen bonding.
 - d) London dispersion forces and hydrogen bonding.
 - e) dipole-dipole forces and London dispersion forces.
9. In the 1920s, Heisenberg, de Broglie and Schrodinger developed what is now called wave mechanics or quantum mechanics. Consider the following statements with regard to this model:
- I. The position of an electron can be exactly found and measured.
 - II. With the use of modern instruments, scientists can watch an electron move from point to point in its orbit.
 - III. Energy levels in quantum mechanics are not limited to certain discrete values, but are actually continuous.
 - IV. An electron has properties of a particle and a wave in the quantum mechanical model of the atom.

Which of the above statements is/are **true**?

- a) III only
 - b) IV only
 - c) I and II
 - d) III and IV
 - e) II, III, and IV
10. Which of the following contains a metal ion that does **not** have a noble gas electron configuration?
- a) $AgCl$ b) $BaCl_2$ c) TiO_2 d) ScF_3 e) KNO_3

11. Which of the following species exhibits resonance?
- a) CH_4
 - b) PCl_5
 - c) OCl_2
 - d) NO_2^-
 - e) At least two of the above species (a-d) exhibit resonance.
12. Which of the following statements is **false** concerning bonding?
- a) Elements with extremely different electronegativities tend to form ionic bonds with each other.
 - b) In an N–O bond, electron density is greater near the O atom.
 - c) An N–O bond is an example of a polar covalent bond.
 - d) In general, chemical bonds form to minimize energy.
 - e) The bond in KBr is formed by sharing electrons.
13. The current model of the atom in which essentially all of an atom's mass is contained in a very small nucleus, whereas most of an atom's volume is due to the space in which the atom's electrons move was established by
- a) Millikan's oil drop experiment.
 - b) Thomson's cathode ray tube experiment.
 - c) Dalton's atomic theory.
 - d) Rutherford's gold foil experiment.
 - e) Bohr's hydrogen model.

Draw the Lewis structures for the following molecules/ions below to assist you in answering questions 14 – 15. (Note: The central atom is listed first.)



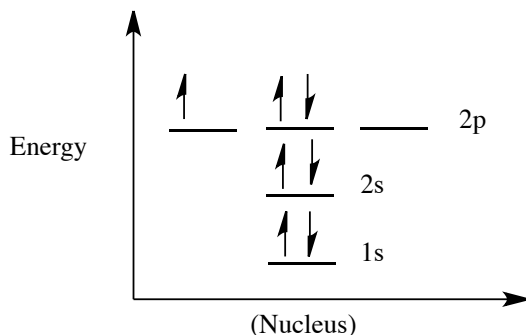
14. How many of the species above have 180° bond angles around the central atom?
- a) 1
 - b) 2
 - c) 3
 - d) 4
 - e) 5
15. Which of the following compounds will be **least** soluble in water?
- a) IF_5
 - b) PF_3
 - c) ClF_2^+
 - d) COS
 - e) KrF_2

16. Answer each of the following questions below. Be thorough in your answers and provide complete support. *Please limit your answers to the space provided.*

a) Identify whether each statement below is true or false, along with the requested explanation.

(i) True or false? If false, correct the diagram to make it true.

The energy level diagram for the ground state of nitrogen is:



(ii) True or false? If true, explain why. If false, provide a counterexample with explanation.

A molecule with a bond dipole must also have a net dipole moment.

(iii) True or false? Whether true or false, provide an example to support your answer.

The expected ground state electron configurations for species in an isoelectronic series are the same.

(iv) True or false? If true, explain why. If false, fix the ranking to make it true.

The following species are listed from lowest to highest boiling point:



b) You and a friend are playing a game with the periodic table. Your friend randomly picks two elements from the table and tells you “Element **M** has more protons than element **Z**.”

(i) Choose the correct statement below (circle one):

- I. Element **M** must have a smaller atomic radius than element **Z**.
- II. Element **M** must have a larger atomic radius than element **Z**.
- III. Element **M** may have a larger or smaller atomic radius than element **Z**.

(ii) Explain your choice using complete sentences and examples to support your ideas.

17. An unknown group 6A atom **X** reacts with atomic fluorine to form the molecule XF_4 . The formation reaction is written as: $\text{X} + 4 \text{F} \rightarrow \text{XF}_4$.

a) Draw the Lewis structure of XF_4 . Clearly include all bonds and lone pairs on X and F.

b) What is the geometry and shape around the central atom X? Is this molecule polar or nonpolar?

c) Explain the general difference between the terms *geometry* and *shape*. How are these used to determine the polarity of a molecule?

d) What intermolecular interactions would occur between two of these XF_4 molecules? List all of them, along with an explanation.