CHEMISTRY 101
Hour Exam III
December 7, 2020
Leveritt/McCarren

Name _____KEY_____

Signature _____

Section _____

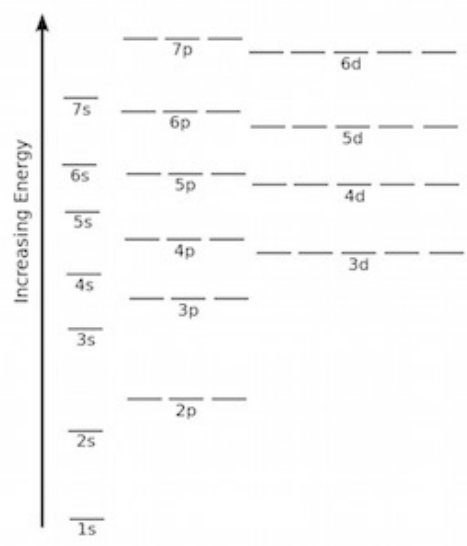
"Ends are not bad things, they just mean that something else is about to begin. And there are many things that don't really end, anyway, they just begin again in a new way. Ends are not bad and many ends aren't really an ending; some things are never-ending."

-C. JoyBell C.

This exam contains 32 questions. The first 15 questions are multiple choice and the remaining questions may be a mix of multiple choice, checkboxes, and drop-down questions. Please be sure to answer all of the questions on the exam. You may use the periodic table and equation sheet provided.

1-15	(30 pts.)	_____
16-28	(14 pts.)	_____
29-32	(16 pts.)	_____
Total	(60 pts)	_____

Useful information:



Part 1: Multiple Choice

+2 points each multiple choice question (#1-15)

1. Consider textbook problem #14 from Chapter 10. This problem asks you to determine whether the following process is endothermic or exothermic. It states:

   "When solid KBr is dissolved in water, the solution gets colder."

   If you stated that this process was endothermic, which of the following is **false**?
   a. Solid potassium bromide is the system.
   b. The water is part of the surroundings.
   c. Solid potassium bromide is lower in energy before it is placed in the water.
   d. It was necessary to exert energy to start this process by initially combining the KBr and the water.
   e. Heat leaves the potassium bromide as it dissolves.

2. Which of the following statements about the early history of the atom is now considered to be **false**?
   a. Atoms combine in simple whole number ratios to form compounds.
   b. At the center of each atom is a very small, dense, nucleus.
   c. Tiny negatively charged electrons move within a positively charged cloud inside each atom.
   d. Each element has unique arrangement of electrons different from atoms of other elements.
   e. All of these statements are still considered to be true.

3. In the "Modern Atomic Theory" activity, you observed that placing a salt consisting of some substance, such as copper(II) sulfate, resulted in the emission of a flame of a particular color. What is **false** about this activity?
   a. The purpose of the Bunsen burner was to add heat in order to excite the electrons in the atoms.
   b. The light being released from the flames was an exothermic process.
   c. All of the colors of light were different for each different salts because the elements in the different salts each had different electron arrangements located in discrete energy levels.
   d. Mixing several different salts and placing them into the Bunsen burner flame could have made white light visible.
   e. The flame of a particular element was not always the same color; the flame produced by the copper(II) ion is sometimes blue and is sometimes red.

4. Atomic orbitals are used to represent where the electrons are located within an atom. What is the physical meaning of the actual shape of the orbital (for example the spherical shape of the s orbital)?
    a. The shape of an orbital defines the surface upon which electrons are most likely moving.
    b. An orbital is defined as a region inside which where electrons are rarely located.
    c. <u>The space designated by an orbital defines a space where electrons are most often moving within.</u>
    d. The electrons are moving with 100% probability within the shape of the orbital.
    e. The shape of the orbital makes it possible to pinpoint the place within an orbital that an electron will be located at a given point in time.

5. How many of the following electron configurations for neutral atoms show noble gases? These can be in the ground or excited states.
    - $1s^2$
    - $[Xe]6s^24f^{14}5d^{10}6p^6$
    - $[He]2s^22p^53s^1$
    - $[Ne]3s^13p^6$

    a. 0 (None of the options display noble gases.)
    b. 1
    c. 2
    d. <u>3</u>
    e. 4 (All of the options display noble gases.)

6. Which of the following atoms or ions could **<u>not</u>** have the following electron configuration?

$$\mathbf{1s^22s^22p^63s^23p^64s^1}$$

    a. A neutral atom of potassium (K)
    b. An ion of calcium resulting when a neutral calcium atom <u>loses one</u> electron (Ca^+)
    c. An ion of titanium resulting when a neutral titanium atom <u>loses three</u> electrons (Ti^{3+})
    d. <u>An ion of chlorine resulting when a neutral chlorine atom gains one electron</u> (Cl^-)
    e. An ion of sulfur resulting when a neutral sulfur atom <u>gains three</u> electrons (S^{3-})

7. Determine the number of unpaired electrons expected in a neutral, ground state atom of nickel. (Hint: The equation sheet shows an electron filling diagram.)
   a. 1
   b. 2
   c. 3
   d. 5
   e. 8

8. Select the option which correctly ranks the atoms below from lowest to highest first ionization energy.
   a. F < Cl < Br < I
   b. I < Cl < Br < F
   c. F < Br < Cl < I
   d. Br < Cl < I < F
   e. I < Br < Cl < F

Consider the following atoms and ions and use these to answer the next two questions:

Rb^+ Kr Se^{2-} As^{3-} Sr^{2+}

9. Which of the following species has the largest radius?
   a. Rb^+
   b. Kr
   c. Se^{2-}
   d. As^{3-}
   e. Sr^{2+}

10. Do the atoms and ions constitute an isoelectronic series? Choose the best answer and explanation for why they do or do not.
    a. *Yes:* All atoms and ions in the series have thirty-six electrons.
    b. *Yes:* All atoms and ions in the series have electron configurations that are the same as that of noble gases.
    c. *It depends:* They make up an isoelectronic series only if some of the electrons are excited.
    d. *No:* Rubidium and strontium are not from the same period (row on the periodic table) as the other elements.
    e. *No:* The atoms and ions in the series do not all come from the same element.

11. Which of the following is <u>always true</u> about polar molecules?

A polar molecule always has…

a. <u>uneven distribution of electrons throughout the molecule.</u>
b. one or more lone pairs of electrons around the central atom.
c. an uneven number of effective pairs around the central atom.
d. atoms of at least two different elements bonded to the central atom.
e. ionic bonds between at least two of the atoms in the molecule.

The next two questions refer to the four species shown below.

IBr_3 CH_2O O_2 CN^-

12. How many of the species above contain a double bond in their Lewis structures?

a. 0 (None of them have double bonds.)
b. 1
c. <u>2</u>
d. 3
e. 4 (All of them have double bonds.)

13. How many of the species above contain an expanded octet (i.e. more than 8 electrons) around their central atom?
a. 0 (None of them display an expanded octet).
b. <u>1</u>
c. 2
d. 3
e. 4 (All of them display an expanded octet.)

14. Give the **molecular shape** around the oxygen atom in CH_3OCH_3.
    a. Linear
    b. Bent/v-shape
    c. Tetrahedral
    d. Trigonal pyramid
    e. Trigonal planar

15. Dimethyl ether, CH_3OCH_3, can be found at room temperature in the liquid phase or in the gas phase. Consider common solvents water, carbon tetrachloride, and propane ($CH_3CH_2CH_3$). Which of these solvents can be expected to mix with CH_3OCH_3?
    a. Water only
    b. Carbon tetrachloride only
    c. Water and carbon tetrachloride
    d. Carbon tetrachloride and propane
    e. Water, carbon tetrachloride, and propane

Please go on to the next page.

Part 2: Free Response

+2 points question 16

+1 point for each question 17-28

Consider a neutral atom of sulfur in the ground state.

16. Select all valid electron configurations for this neutral atom. (Note: one or more choices may be correct.)
    - ☐ **$1s^2 2s^2 2p^6 3s^2 3p^4$**
    - ☐ $[He]2s^2 2p^4$
    - ☐ **$[Ne]3s^2 3p^4$**
    - ☐ $1s^2 2s^2 2p^6 3s^6$
    - ☐ $1s^2 2s^2 2p^4$

17. Identify the type of bond formed between each of the following. Each choice may be used once, more than once or not at all.
    (Drop-down with ionic, polar covalent, and non-polar covalent)
    a. An atom of sulfur and an atom of magnesium **(ionic)**
    b. An atom of sulfur and an atom of oxygen **(polar covalent)**
    c. An atom of sulfur and another atom of sulfur **(nonpolar covalent)**

18. Rank the bonds formed from least polar to most polar. Each answer choice is used only once.

    (Drop-down with least-polar, middle, most-polar for each choice)

    Mg – S bond **(most)**

    S – O bond **(middle)**

    S – S bond **(least)**

19. Give the shape of the SO_2 molecule. **V-shape/bent**

20. Can resonance structures be drawn for SO_2? **Yes**

Consider a neutral atom of Xenon (Xe) in the ground state. (Note: one or more choices may be correct.)

21. Select all valid electron configurations for this neutral atom.
    - ☐ **$[Kr]5s^2 4d^{10} 5p^6$**
    - ☐ $[Ar]4s^2 3d^{10} 4p^6$
    - ☐ $[Kr]5s^2 5d^{10} 5p^6$
    - ☐ $[Kr]5s^2 5p^{10}$
    - ☐ $[Ar]4s^2 4p^6$

22. Identify the type of bond formed between each of the following. Each choice may be used once, more than once or not at all.
    (Drop-down with ionic, polar covalent, and non-polar covalent)
    d. An atom of xenon and an atom of fluorine (**polar covalent)**
    e. An atom of xenon and atom of bromine (**polar covalent)**
    f. An atom of xenon and an atom of chlorine (**polar covalent)**

23. Rank the bonds formed from least polar to most polar. Each choice will be used only once.

    (Drop-down with least-polar, middle, most-polar for each choice)

    Xe - F bond **(most)**

    Xe - Br bond **(least)**

    Xe - Cl bond **(middle)**

24. Give the shape of the $XeCl_2$ molecule. **Linear**

25. Can resonance structures be drawn for $XeCl_2$? **No**

Consider element "X" which is a ground-state neutral element with an atomic number between #1 and #20 on the periodic table. Use the information below to identify element X.

The electron configuration of element X ends in $2s^2 2p^n$, where n represents some number of electrons in the 2p level.

26. What period (horizontal row on the periodic table) is element X in? **2**

Molecule XF_2 has tetrahedral electron pair geometry and bent shape.

It is not possible to draw resonance structures for the molecule XF_2.

27. What is element X? **oxygen**

28. Identify the type of bond formed between each of the following. Each choice may be used once, more than once or not at all.
    g. An atom of X and an atom of magnesium **(ionic)**
    h. An atom of X and an atom of chlorine **(polar covalent)**
    i. An atom of X and an atom of phosphorus **(polar covalent)**

+4 points each question 29-32

(0.4 points each blank)

The following list pairs of molecules, each which have similar formulas. Draw Lewis structures for each molecule in the pairs and use those Lewis structures to give the electron pair geometry, molecular shape, and polarity around each central atom.

Then, for each molecule, give the strongest intermolecular force present between different molecules of that type. Then, select the substance within the pair that can be expected to have a stronger boiling point. Justify your reasoning by selecting the correct answer.

29. Set 1

Molecule	Electron Pair Geometry	Molecular Shape	Polar?
CO_2	**Linear**	**Linear**	**No**
N_2O (N is central atom.)	**Linear**	**Linear**	**Yes**

Compare the boiling points of the two molecules by selecting the correct answers below:

- The strongest IMFs present between molecules of CO_2 are **London dispersion forces**.
- The strongest IMFs present between molecules of N_2O are **dipole-dipole interactions**.
- The molecule with the highest boiling point is **N_2O**, because **it has a stronger type of intermolecular forces**.

30. Set 2

Molecule	Electron Pair Geometry	Molecular Shape	Polar?
SiF_4	**Tetrahedral**	**Tetrahedral**	**No**
SF_4	**Trigonal bipyramid**	**See-saw**	**Yes**

Compare the boiling points of the two molecules by selecting the correct answers below:

- The strongest IMFs present between molecules of SiF_4 are **London dispersion forces**.
- The strongest IMFs present between molecules of SF_4 are **dipole-dipole interactions**..
- The molecule with the highest boiling point is **SF_4**, because **it has a stronger type of intermolecular forces**.

31. Set 3

Molecule	Electron Pair Geometry	Molecular Shape	Polar?
$XeCl_4$	**Octahedral**	**Square planar**	**No**
CCl_4	**Tetrahedral**	**Tetrahedral**	**No**

Compare the boiling points of the two molecules by selecting the correct answers below:

- The strongest IMFs present between molecules of $XeCl_4$ are **London-dispersion forces**.
- The strongest IMFs present between molecules of CCl_4 are **London-dispersion forces**.
- The molecule with the highest boiling point is **$XeCl_4$**, because **it has the same type of intermolecular forces as the other molecule, but more electrons overall.**

32. Set 4

Molecule	Electron Pair Geometry	Molecular Shape	Polar?
HF	**tetrahedral**	**Linear**	**Yes**
HBr	**tetrahedral**	**Linear**	**Yes**

Compare the boiling points of the two molecules by selecting the correct answers below:

- The strongest IMFs present between molecules of HF are **hydrogen bonding forces**.
- The strongest IMFs present between molecules of HBr are **dipole-dipole interactions.**
- The molecule with the highest boiling point is **HF**, because **it has a stronger type of intermolecular forces**.

STOP. You have reached the end of the test.