

CHEMISTRY 101
Hour Exam III
December 7, 2017
Andino/McCarren

Name _____

Signature _____

Section _____

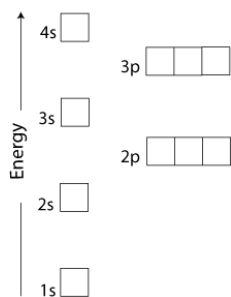
"The ultimate measure of a man is not where he stands in moments of comfort and convenience, but where he stands at times of challenge and controversy."

— Martin Luther King Jr.

This exam contains 17 questions on 10 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	(12 pts.)	_____
17	(18 pts.)	_____
Total	(60 pts)	_____

Useful information:



- Select the option that correctly ranks the elements from smallest to largest radius.
 - $\text{Sr} < \text{Ni} < \text{N} < \text{F}$
 - $\text{Sr} < \text{Ni} < \text{F} < \text{N}$
 - $\text{N} < \text{F} < \text{Ni} < \text{Sr}$
 - $\text{F} < \text{Ni} < \text{N} < \text{Sr}$
 - $\text{F} < \text{N} < \text{Ni} < \text{Sr}$

- Select the statement which is **true** about the following process. The system is underlined for each of the answer choices.

Ammonium nitrate, NH_4NO_3 , is a major component of explosives. Solid ammonium nitrate is added to a beaker of distilled water. The temperature of the water decreases as the ammonium nitrate dissolves.

- Water getting colder is an endothermic process because endothermic processes are more often associated with lower temperatures.
 - Water getting colder is an exothermic process because colder water is higher in energy than warmer water.
 - Ammonium nitrate dissolving is an endothermic process because heat is transferred from the water to the ammonium nitrate in order for the NH_4NO_3 to dissolve.
 - Ammonium nitrate dissolving is an endothermic process because coldness from the ammonium nitrate was added to the water.
 - Ammonium nitrate dissolving is an exothermic process because heat leaves the water as the ammonium nitrate dissolves.
- Which set of statements best describes the difference between the currently accepted model of the atom from the Rutherford model of the atom?

	Rutherford	Current
a)	Atoms are divisible and consist of multiple parts, including a positively charged nucleus.	Atoms can be thought of as indivisible, solid spheres.
b)	An atom's electrons are positioned outside the nucleus of the atom.	An atom's electrons can be predicted to be found in regions of space called orbitals located outside the nucleus of the atom.
c)	Electrons are present within the nuclei of atoms.	Electrons are present outside the nuclei of atoms.
d)	Atoms can be thought of as indivisible, solid spheres.	Atoms are divisible and consist of multiple parts, including negatively charged electrons.
e)	Electrons orbit the nucleus of the atom in specific energy levels on defined paths.	Electron location cannot be determined, but it is possible to predict where an electron is likely to be located 90% of the time.

Consider the following species to answer questions 4 - 6. The central atom is listed first in each situation.



4. How many of the compounds above have a tetrahedral molecular shape?

- a) 1 b) 2 c) 3 d) 4 e) 5

5. How many of the compounds above are polar?

- a) 1 b) 2 c) 3 d) 4 e) 5

6. Which of the compounds above has at least one 120° bond angle?

- a) KrF_4 b) TeF_4 c) CF_4 d) NF_3 e) XeF_2
-

7. All of the following electron configurations – ground or excited state – represent neutral elements from the same family, **except** for _____.

- a) $[\text{Xe}] 6s^2 4f^{14} 5d^{10} 6p^5$
b) $[\text{Ne}] 3s^2 3p^4 4s^1$
c) $[\text{Kr}] 5s^2 4d^{10} 5p^3 6s^1 5d^1$
d) $1s^2 2s^2 2p^5$
e) $[\text{Ar}] 4s^2 3d^{10} 4p^6$

8. Which is **false** about the compound Mg_3X_2 , where X represents some element on the periodic table?

- a) **Ions** of magnesium and element X both have noble gas electron configurations.
b) A possible electron configuration of **neutral** element X is $[\text{Ne}]3s^2 3p^3$.
c) Electrons are shared evenly between the magnesium and X ions.
d) The bond formed between magnesium and X is more polar than the bond that would be formed between an atom of carbon and X.
e) Energy was released in forming the bond between the magnesium and element X.

9. Which option is **false** regarding the HF molecule?
- a) Electrons in this molecule are more likely to be found close to the F atom than the H atom because the F atom is more electronegative and therefore better able to attract electrons.
 - b) HF is a polar molecule because electrons are more attracted to one side of the molecule than the other.
 - c) The Lewis structure for HF should show 8 total valence electrons.
 - d) Hydrogen bonds exist between separate molecules of HF bonding together.
 - e) The bond between the H and the F atom is more polar than the bond between the bond between Na and F in the NaF molecule because H is more electronegative than Na.
10. Which is **false** regarding atomic orbitals and the currently accepted atomic model?
- a) As the principal energy level, n, increases, the types of orbitals present increase in complexity.
 - b) The specific colors emitted by an excited hydrogen atom are different than the spectrum of colors emitted by an excited potassium atom.
 - c) As an electron becomes excited, it moves further from the nucleus of the atom.
 - d) Electron orbitals can be thought of as orbits, in which an electron moves around the nucleus of the atom in a defined path.
 - e) White light results from a continuous (non-quantized) spectrum of energy levels.
11. Consider each set of elements listed below. Which element in each set has the **highest** ionization energy?

Set 1	C, N, O, F, Cl
Set 2	Si, P, S, Cl, Br
Set 3	Ge, As, Se, Br, I

- a) C, Si, Ge
- b) N, P, As
- c) O, S, Se
- d) F, Cl, Br
- e) Cl, Br, I

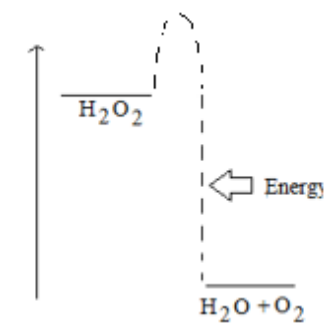
12. The atomic radius of hydrogen is _____ than the radius of an atom of lithium, and the size of the hydrogen 1s orbital is _____ the size of the lithium 1s orbital.
- larger; smaller than
 - larger; larger than
 - smaller; smaller than
 - smaller; larger than
 - smaller; equal to
13. Select the substance with the **highest** boiling point.
- Br₂
 - Cl₂
 - F₂
 - N₂
 - O₂
14. Select the substance(s) which would be expected to be insoluble in methanol, CH₃OH.
- CH₃CH₂CH₃
 - CH₃OCH₃
 - CH₃CH₂OH
 - All three of these molecules are insoluble in methanol.
 - At least two of these molecules (a-c) are insoluble in methanol.

Please go on to question #15 on the next page...

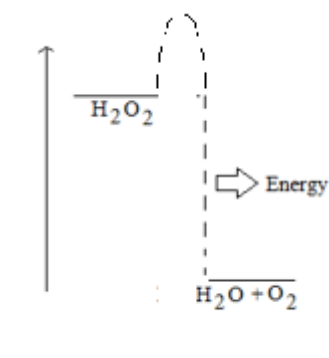
15. In the “Elephant’s Toothpaste” demonstration, hydrogen peroxide (H_2O_2) naturally decomposes to form liquid water and oxygen gas with the aid of an iodine catalyst. As the reaction occurs, foam is produced, and the products of the reaction are warm to the touch (not to mention steaming and dangerous!). Select the image below which best corresponds to the relationship between the relative energy of the reactants and the products.



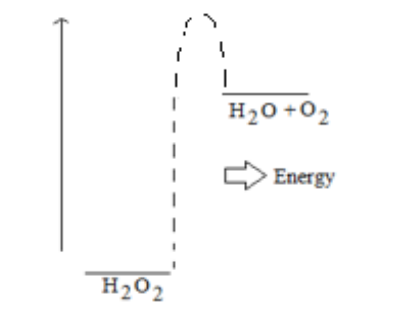
a)



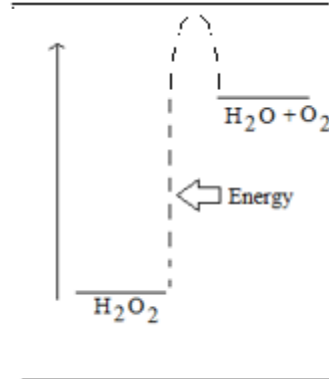
c)



b)



d)



e) None of these is correct.

Please go on to question #16 on the next page...

16. Please completely answer each of the questions below. Limit your explanations to the space provided.

a. Consider the most stable **ion** of sulfur. Give the full, long form electron configuration of this ion.

b. Identify ions or atoms of a halogen, a noble gas, an alkali metal, and an alkaline earth metal that form an isoelectronic series with this sulfur ion. Explain why these constitute an isoelectronic series.

c. Rank the atoms and ions you gave from parts a. & b., including the sulfur ion, in your isoelectronic series in order of increasing (smallest to largest) ionization energy. Justify your answer, including explaining the meaning of ionization energy.



- d. Will each of the atoms or ions in this series have the same radius? If you answer yes, explain why, including an atomic-level explanation. If you answer no, explain why, including an atomic-level explanation, and rank the atoms and ions in order of increasing atomic radius in the boxes below. If you answer yes, you may leave the boxes blank.

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Please go on to question #17 on the next page...

17. Consider unknown elements X, Y, and Z which form compounds XO_2 , YO_3 , and $\text{Mn}(\text{ZO}_3)_4$, respectively. Note that manganese is bonding with polyatomic ion ZO_3^- in the third compound.

a. Use the following information to identify X, Y, and Z:

- X is in period (row) 2, while Y and Z are in period 3.
- Element Z is more electronegative than element Y and contains one unpaired electron.
- Element X has fewer valence electrons than element Y, but both have two unpaired electrons in their orbital filling diagrams. (*A blank diagram appears on the cover of exam.)

Compound	Unknown Element Identity
XO_2	X:
YO_3	Y:
$\text{Mn}(\text{ZO}_3)_4$	Z:

b. Fill out the table below for each of the three compounds. Draw one Lewis structure for each compound, and indicate whether or not it is possible to draw other resonance structures. Then, fill in the rest of the table. In each structure, include the element you identified in part a) in your Lewis structure. (The Lewis structures should not have X, Y, or Z included but should actually contain the symbol of the correct element.)

	Number of Valence Electrons	Lewis Structure	Resonance Structures Possible?	Electron Pair Geometry	Molecular Shape	Bond Angles	Polar?
XO_2							
YO_3							
ZO_3^-							

- c. Consider the two compounds XO_2 and YO_3 from the previous question. One of these compounds is present as a liquid at room temperature and the other is present as a gas. Identify the compound present as a liquid and explain why, including a discussion of the strongest intermolecular forces in each of the compounds.



You have reached the end of the exam. Nothing written after this page will be graded.