CHEMISTRY 101
Hour Exam III
April 28, 2022
McCarren

Name _____

Signature _____

Section _____

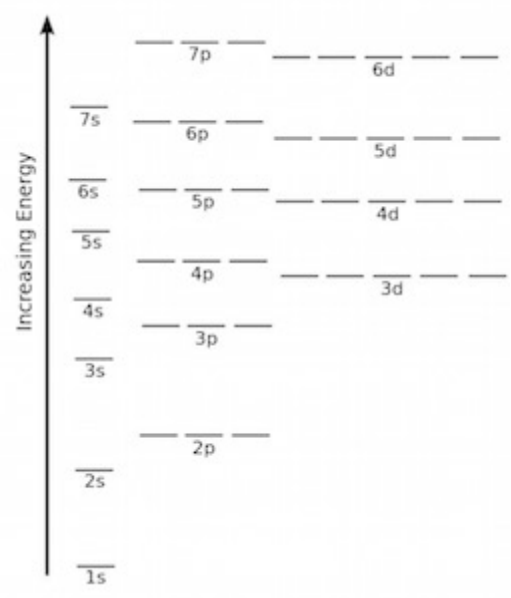
"I never went through an easy fight. Every fight has been hard fought."

– Katie Taylor, Olympic boxer

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)	_____

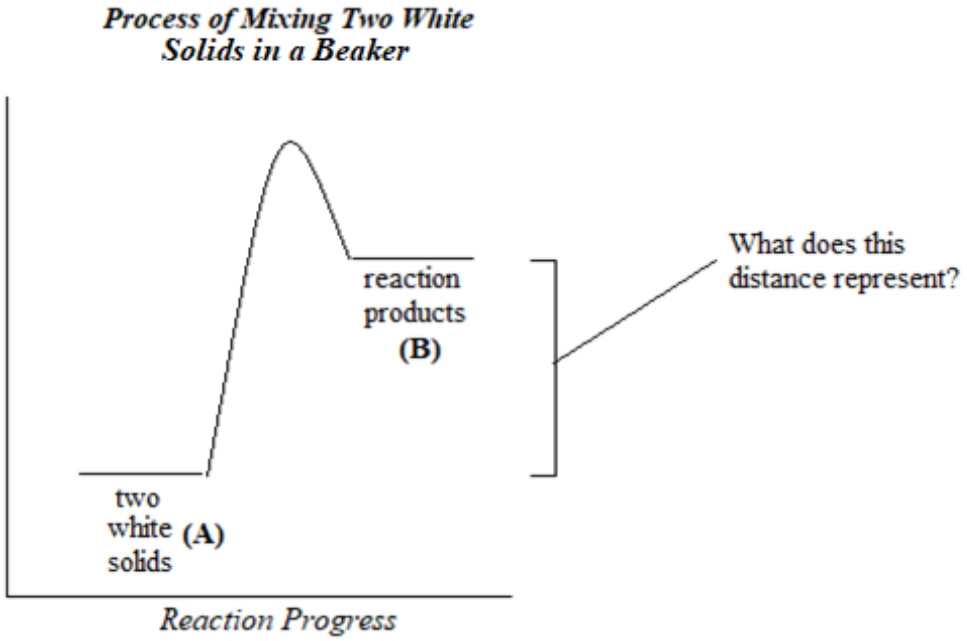
Useful information:



Part 1: Multiple Choice

1. We have seen several of the following demonstrations in lecture. Which of the following is an **exothermic** process? The system is underlined in each case.
   a. Water boils on the stove.
   b. Two solids mix in a beaker and the beaker becomes colder.
   c. Ice cream melts on a hot day.
   d. Liquid nitrogen boils when poured into the air.
   e. A racquetball hardens in liquid nitrogen.

2. Consider the *incomplete* diagram below which describes the process which involved mixing the two white solids in the beaker which froze the beaker to the wooden board. What is represented by the distance between points A and B as shown? (Note: the y-axis of the diagram is purposefully not labeled.)



The distance between points A and B shows the amount of overall….
   a. product produced in the reaction.
   b. limiting reactant used in the process.
   c. energy absorbed during the reaction.
   d. energy released during the reaction.
   e. energy required to start the reaction.

3. Which of the following is **false** regarding our current understanding of the atom?
    a. Atoms may lose or gain charged particles called electrons to form ions.
    b. An atom primarily consists of empty space.
    c. Electrons in an atom are more likely to be located in some places outside the center of the atom compared to others.
    d. All neutral atoms of a specific element are made up of the same number of protons, neutrons, and electrons.
    e. All neutral atoms contain a dense positively charged center called a nucleus.

In this unit, we have explored several models which help us to describe atoms, their structure, and the way atoms connect to form molecules. Orbitals, electron configurations, and Lewis structures are three of these models, though all have limitations. Answer the three questions below regarding each of these models.

4. Which of the following is **true** regarding orbitals?

    Orbitals…
    a. become simpler in shape moving further from the nucleus of the atom.
    b. provide a road map to describe electron movement.
    c. describe where the electrons are located most often.
    d. hold two electrons in a single s orbital and six electrons in a single p orbital.
    e. show the specific locations of each electron.

5. Electron configurations are one of tools we have used to describe atoms of individual elements. What is one of the limitations of using an electron configuration as a model?

    Individual ground state electron configurations for neutral atoms do not….
    a. contain the correct number of electrons in an atom.
    b. demonstrate that electrons are located within energy levels.
    c. show uncertainty of electron location.
    d. acknowledge that different shapes of orbitals exist.
    e. enable the identification of an element.

6. Lewis structures are one of the models we have used to describe the structure of a molecule. Which of the following is always **true** regarding the use of Lewis structures as a model?

    A drawing of a Lewis structure shows….

    a. a molecule's three-dimensional shape.
    b. the magnetic properties of a molecule.
    c. which valence electrons were donated to the structure by which atoms.
    d. which atoms in a molecule are connected to which.
    e. the ways in which electrons travel throughout the molecule.

Use the electron configuration shown below to answer the next two questions.

$[Kr]5s^2 4d^8$

7. This is the expected ground state electron configuration for which neutral atom?

   a. Pd
   b. Ag
   c. Ni
   d. Co
   e. Cu

8. How many unpaired electrons are expected to be present for an atom with this electron configuration? (Hint: an orbital diagram is available on the front cover of the test.)
   a. 1
   b. 2
   c. 3
   d. 5
   e. 8

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9. Which option below correctly ranks the neutral atoms in group 7 from smallest to largest atomic radius?

   a. I < Br < Cl < F
   b. F < Cl < Br < I
   c. I < Br < Cl < F
   d. F < Br < Cl < I
   e. Br < Cl < F < I

10. Which option below correctly ranks the atoms and ions below from easiest to remove an electron to hardest to remove an electron?

Ca Ca^{+2} Ca^{+}

	Easiest		Hardest
a.	Ca	Ca^{+}	Ca^{+2}
b.	Ca^{+2}	Ca^{+}	Ca
c.	Ca	Ca^{+2}	Ca^{+}
d.	Ca^{+2}	Ca	Ca^{+}
e.	Ca^{+}	Ca^{+2}	Ca

The four molecules below all contain at least one atom of oxygen. Draw Lewis structures for these molecules, determine the shapes, and use them to answer next three questions.

CO_2 SO_2 OF_2 H_2O

11. Which of these molecules has a linear shape?
    a. CO_2
    b. SO_2
    c. OF_2
    d. H_2O
    e. At least two of the molecules have a linear shape.

12. How many of these molecules are polar?
    a. 0 (None of the molecules are polar.)
    b. 1
    c. 2
    d. 3
    e. 4 (All four of the molecules are polar.)

13. Resonance structures can be drawn for two of these molecules. Which two molecules are these?
    a. SO_2 and OF_2
    b. OF_2 and H_2O
    c. H_2O and SO_2
    d. CO_2 and OF_2
    e. CO_2 and SO_2

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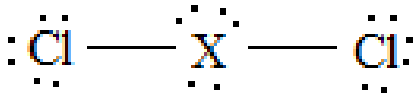
14. Draw Lewis structures for each of the molecules below. How many of the structures have octahedral electron pair geometry?

PF_5 XeF_4 SF_4 CF_4

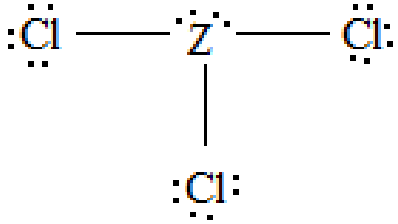
    a. 0 (None of the four structures have octahedral electron pair geometry.)
    b. 1
    c. 2
    d. 3
    e. 4 (All four of the structures have octahedral electron pair geometry.)

15. The two molecules below both have central atoms which accommodate expanded octets. The central atom(s) for each molecule are nonmetals which reside in the fourth row of the periodic table. Which of the following could be the central atom for each molecule?

Molecule 1



Molecule 2



	Molecule 1	**Molecule 2**
a.	Br	Kr
b.	Br	Br
c.	Kr	Kr
d.	Se	Se
e.	Kr	Br

Please go on to the next page.

Part 2: Free Response

16. Show what you know. Please thoroughly answer each of the questions in the spaces below.
    a. A bond between carbon and oxygen is shown below.

Describe the nature of this bond by explaining the following:

- Explain whether electrons are donated, shared unequally, or shared equally within this bond and how you know
- If electrons are donated or shared unequally, which atom the electrons spend most time near, and how you know this based on electronegativity

    b. Consider the excited state electron configuration for a neutral element shown below.

$$\mathbf{1s^2 2s^2 2p^1 3s^1}$$

Identify this element and also do the following:

- Explain how you identified the element from the excited state configuration
- Give the ground state electron configuration for the neutral atom of the element

c. An isoelectronic series consists of atoms and/or ions which all have the same number of electrons. Two ions which both have the same number of electrons are shown below.

Na^+ **F^-**

These two ions have different sizes. Explain these different sizes by…

- Giving the number of protons and electrons in each ion
- Identifying which ion is larger
- Explaining why that ion is larger based on the atomic structure of both of the ions

Please go on to the next page.

17. Answer the questions regarding Set 1 and Set 2 of molecules below.

Set 1

The following molecules O_2, I_2, and Br_2 have the same shape but are in different phases at room temperature.

a. Draw the Lewis structures and give the shapes, polarity, and strongest intermolecular forces for each.

	Lewis structure	**Shape**	**Polar?**	**Strongest Intermolecular Forces**
I_2				
Br_2				
O_2				

b. At room temperature, one of these substances is a solid, one is a liquid, and one is a gas. Identify which is which and fill in the spaces in the table below to indicate this and explain why you ranked them the way you did. Your explanation should include an identification of the strongest intermolecular forces between molecules of each of the substance and an explanation of their relative strengths.

solid	**liquid**	**gas**

Please go on to the next page.

Set 2

The following molecules all consist of similar atoms but have different boiling points.

c. Draw the Lewis structures and give the geometry, shape, and bond angle around one carbon atom, and state whether the molecule overall is polar or nonpolar.

	Lewis structure	**Geometry (around one carbon atom)**	**Shape (around one carbon atom)**	**Bond angles (around one carbon atom)**	**Polar?**
CH_3OH					
CH_2O					
C_2H_2					

d. The boiling points for each of these three substances are shown below. Fill in the spaces below by ranking the three molecules in the table from lowest to highest boiling point and then explain your process for doing this. Your explanation should include an identification of the strongest intermolecular forces between molecules of each of the three substances and discussion of their relative strengths.

-84.0°C	**-19.0°C**	**64.7°C**

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

Chem 101 Scratch Paper

NOTHING WRITTEN ON THIS PAGE WILL BE GRADED

Periodic Table of the Elements