CHEMISTRY 101
Hour Exam III
April 27, 2023
McCarren

Name _____

Signature _____

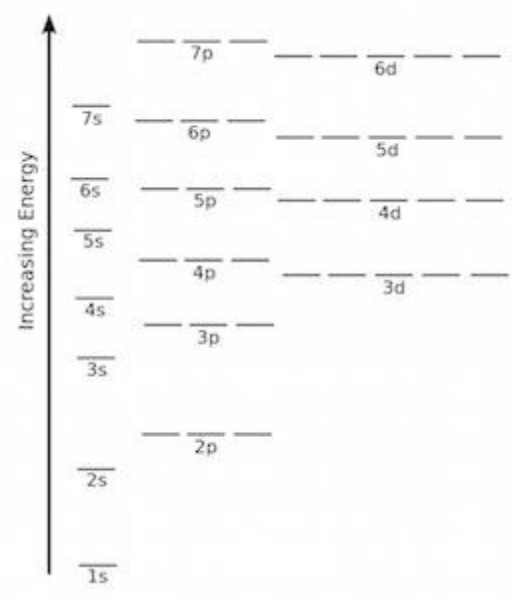
Section _____

"The difference between ordinary and extraordinary is that little extra." — Jimmy Johnson

This exam contains 17 questions on 9 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)	_____

Useful information:



Part 1: Multiple Choice

1. Which is **true** about an **exothermic** reaction?
    a. Energy in the form of heat is added from the surroundings into the reaction system.
    b. The products of the reaction are less stable than the reactants.
    c. No activation energy is needed for this reaction to begin.
    d. The reaction must occur at a high temperature.
    e. The products have less potential energy than the reactants.

2. How many of the following phase changes are considered to be **endothermic** processes? The system is underlined in each case.
    - **Dry ice** subliming to become carbon dioxide gas
    - **Ice** melting to form water
    - **Molten (liquid) iron** hardening to become solid iron
    - **Water** boiling to form steam

    a. 0 (None of the processes are endothermic.)
    b. 1
    c. 2
    d. 3
    e. 4 (All four of the processes are endothermic.)

3. You are studying with a friend and they are having trouble understanding what an atom looks like. You want to make a drawing of an atom to help them. How should you draw the atom?

    Your drawing of the atom should…

    a. look like a solid sphere.
    b. show electrons orbiting a nucleus on circular paths.
    c. include a large positively charged cloud for most of the atom.
    d. include a lot of empty space where electrons might be.
    e. include a large nucleus consisting of protons.

4. Recall the "flame test" demonstration from the lecture, in which we saw different elements burn with various flames. What is **true** about this demonstration and our understanding of the structure of the atom?
    a. Using the match to ignite the salts was an exothermic process.
    b. The process of the salts burning was an endothermic process.
    c. As the salts burned, electrons moved further from the nucleus of the atom.
    d. At least one of the salts burned with a white flame due to having a continuous spectrum of energy.
    e. The different colors for each individual element were a result of unique electron arrangements.

5. Which is **true** about orbitals as they relate to our current understanding of atomic structure?

    Orbitals…
    a. are solid shells positioned outside the center of the atom.
    b. show the spaces where electrons must be present.
    c. all have spherical shapes.
    d. each hold an octet of electrons.
    e. become more complex for higher energy levels.

6. What is the ground state electron configuration for a neutral atom of palladium?
    a. $[Kr]5s^2 4d^8$
    b. $[Kr]5s^2 5d^8$
    c. $[Ar]5s^2 4d^8$
    d. $[Kr]5s^1 4d^9$
    e. $[Ar]4s^2 3d^8$

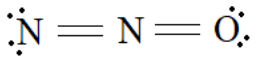
7. The following electron configuration is for a neutral atom in an excited state. Which atom does this electron configuration represent?

    $[Ar]4s^2 3d^5 4p^1$

    a. Fe
    b. Mn
    c. Cr
    d. Mo
    e. Tc

8. Select the option which ranks the atoms below in order from smallest to largest radius.
    a. Cr < Fe < P < F
    b. F < P < Cr < Fe
    c. F < P < Fe < Cr
    d. F < Fe < P < Cr
    e. Cr < P < Fe < F

9. Consider the Lewis structure below, which shows the most stable structure for a molecule of N_2O. Complete the statement below which best describes the character of the bond between the two nitrogen atoms and the polarity of the molecule overall.



The bond between N and N is best considered to be _____, and the entire N_2O molecule overall is _____.

    a. nonpolar covalent; nonpolar
    b. polar covalent; polar
    c. polar covalent; nonpolar
    d. nonpolar covalent; polar
    e. ionic; polar

10. What is one of the limitations of this Lewis structure for N_2O?

The Lewis structure does <u>not</u> show….

    a. the number and type of each of the atoms in the molecule.
    b. which atoms are connected to which.
    c. the uncertainty of electron location.
    d. whether the bonds are single, double, or triple bonds.
    e. how many valence electrons are in the molecule.

11. Which is **true** about intermolecular forces?
    a. Stronger intermolecular forces mean that a substance is more likely to be in the gas phase.
    b. Molecules with stronger intermolecular forces boil at higher temperatures.
    c. London dispersion forces get weaker with increased molecule size.
    d. For molecules of similar sizes, London dispersion forces are stronger than hydrogen bonds.
    e. For molecules of similar size, polar molecules have weaker intermolecular forces than nonpolar molecules.

Draw the Lewis structures for the five molecules below and use these to answer the next four questions.

H_2 SO_2 HCN HF Br_2

12. Which of the molecules contains a triple bond in its Lewis structure?
    a. H_2
    b. SO_2
    c. HCN
    d. HF
    e. Br_2

13. For which of the molecules is it possible to draw resonance structures?
    a. H_2
    b. SO_2
    c. HCN
    d. HF
    e. Br_2

14. How many of the substances would be expected to dissolve in water?
    a. 1
    b. 2
    c. 3
    d. 4
    e. 5 (All five of the substances are polar.)

15. Which of the substances is expected to have the highest boiling point?
    a. H_2
    b. SO_2
    c. HCN
    d. HF
    e. Br_2

Part 2: Free Response

16. Parts a – c each include pairs of substances. Answer the questions below, appropriately addressing the differences in the characteristics of the two substances in each pair.

a. It is easier to remove an electron from neutral magnesium (**Mg)** than to remove an electron from the most stable magnesium ion (**Mg^{+2})**. Explain why it is easier to remove an electron from neutral magnesium. In your answer, include:
   - How the number of electrons in each species compare
   - How the sizes of each compare
   - How these differences in electrons and size relate to difficulty to remove an electron.

b. The neutral helium atom (**He**) has a smaller radius than the neon atom (**Ne**). Explain why helium is smaller than neon. Your answer should go beyond simply stating a trend and should explain why these two atoms have different sizes based on their atomic structures.

c. The sulfur ion ($\mathbf{S^{-2}}$) has a larger radius than the potassium ion ($\mathbf{K^{+}}$). Explain why the sulfur ion is larger than the potassium ion. Your explanation should include:
   - The number of protons in each species
   - The number of electrons in each species
   - How the number of protons and electrons relate to size.

Please go on to the next page.

17. The compounds in each of the three sets below all have similar formulas. However, within each of the three sets, each compound has a different electron pair geometry. Draw Lewis structures for each of the three compounds on scratch paper and use those Lewis structures to fill in the table. Answer the follow up questions about each set at the end.

Set 1:

a. Fill in the table for set 1 below. Each molecule consists of a central atom which is connected to four fluorine atoms.

Formula	**Electron pair geometry**	**Molecular Shape**	**Polar or nonpolar?**	**Strongest Intermolecular Forces**
SF_4				
CF_4				
XeF_4				

Set 2:

b. Fill in the table for set 2 below. Each molecule consists of a central atom which is connected to two oxygen atoms.

Formula	**Electron pair geometry**	**Molecular Shape**	**Polar or nonpolar?**	**Strongest Intermolecular Forces**
CO_2				
XeO_2				
SeO_2				

Set 3:

c. Fill in the table for set 3 below. Each molecule consists of a central atom which is connected to three chlorine atoms.

Formula	**Electron pair geometry**	**Molecular Shape**	**Polar or nonpolar?**	**Strongest Intermolecular Forces**
PCl_3				
BCl_3				
$BrCl_3$				

d. Which compound each set is expected to have the **lowest** boiling point? List three compounds, selecting one of the three compounds from each of set 1, set 2, and set 3.

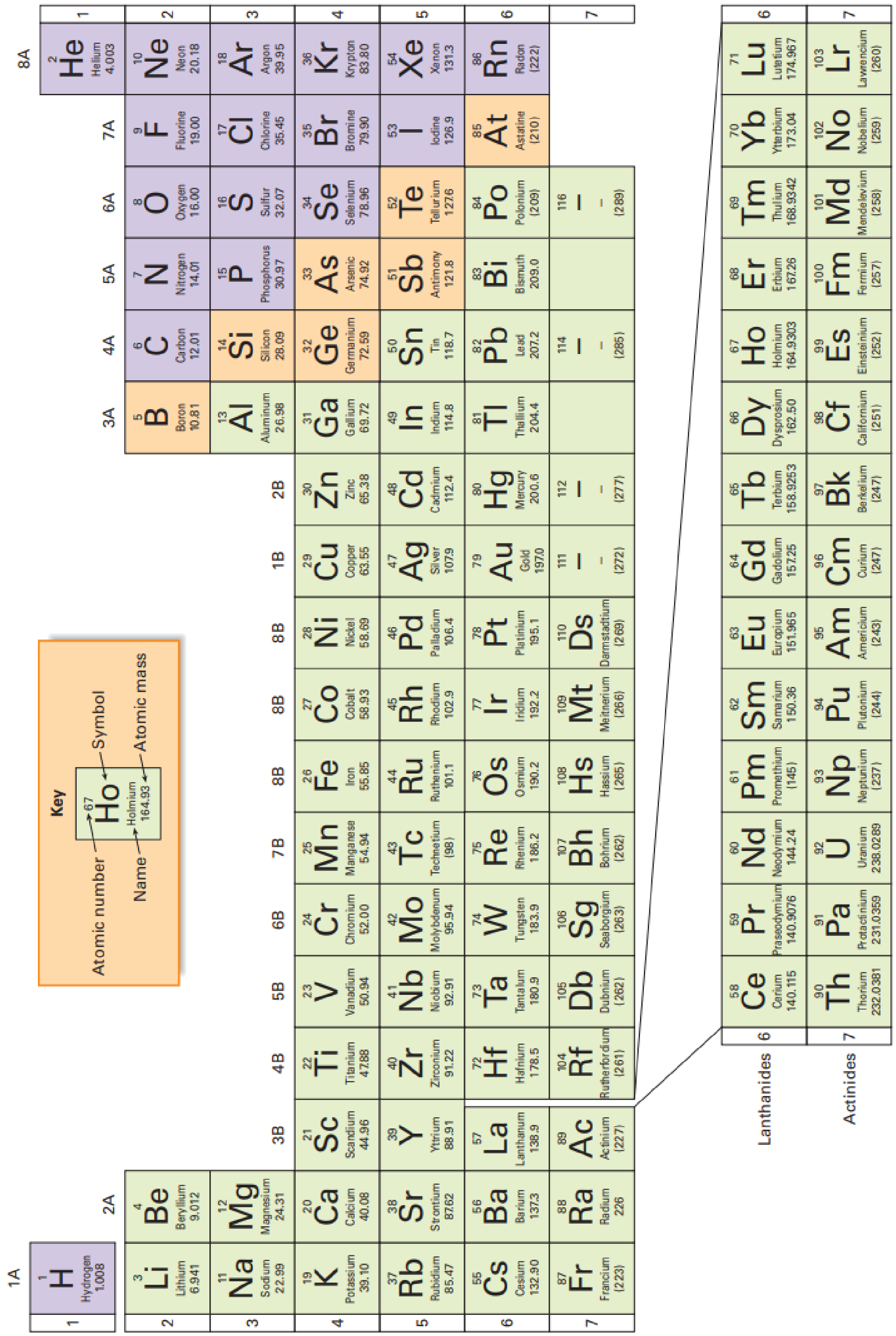
- Compound from set 1 with lowest boiling point: _____
- Compound from set 2 with lowest boiling point: _____
- Compound from set 3 with lowest boiling point: _____

e. Of the three compounds from part d., one of them is a liquid at room temperature and the other two are gases. Which of the compounds is a liquid? Briefly explain your answer, including giving the strongest intermolecular forces between molecules of each of the three compounds.

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

SCRATCH PAPER

Nothing written on this page will be graded.



Periodic Table of the Elements