CHEMISTRY 101
Hour Exam I
February 15, 2022
McCarren

Name _____

Signature _____

Section _____

"The new normal is to always be better than your old normal." – Garrison Wynn

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	(15 pts.)	_____
17	(15 pts.)	_____
Total	(60 pts)	_____

Useful Information:

$PV = nRT$

$K = °C + 273$

$R = 0.08206$ L•atm/mol•K ≈ 0.0821 L•atm/mol•K

Density = mass / volume

Avogadro's number = 6.022×10^{23}

1 L = 1000 mL

1 atm = 760. torr

Assume atmospheric pressure is 1.00 atm (unless explicitly told otherwise).

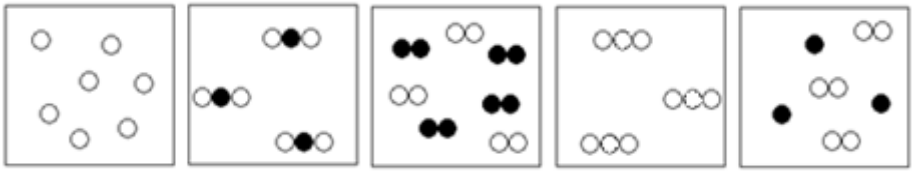
Always assume ideal behavior for gases (unless explicitly told otherwise).

Part 1: Multiple Choice

1. The speed limit on interstate 57 between Champaign and Chicago is 70 miles per hour. If you are driving at this speed, how many feet do you travel each second?
   (1 mile = 5280 feet)

   a. 3.86×10^{-6} feet
   b. 47.7 feet
   c. 83.8 feet
   d. 103 feet
   e. 6,160 feet

2. How many of the five diagrams below show substances which are mixtures?



   a. 1
   b. 2
   c. 3
   d. 4
   e. 5 (All five diagrams show mixtures.)

3. A compound can always also be considered a molecule. However, a molecule is not always considered a compound. Why is this true?
   a. A compound must consist of at least two different elements whereas a molecule can consist of only one type of element.
   b. A compound must consist of at least two different atoms whereas a molecule can be made up of just one atom.
   c. A compound must be a mixture whereas a molecule can be a pure substance.
   d. A compound is always heterogeneous whereas a molecule may be heterogeneous or homogeneous.
   e. A compound is created through a chemical change whereas a molecule can be created through a chemical or physical change.

4. Consider the pairs of compound names and formulas below, all of which include at least one polyatomic ion. How many of the formulas are written correctly for the names provided?

Name	**Formula**
cobalt(II) nitrate	$Co(NO_3)_2$
iron(II) hydroxide	$FeOH_2$
sodium cyanide	NaCN
magnesium carbonate	$Mg(CO_3)_2$

   a. 0 (None of the formulas are written correctly for the names given.)
   b. 1
   c. 2
   d. 3
   e. 4 (All 4 formulas are written correctly for the names given.)

5. When explaining the concept of a mole, we may hear the phrase, "A mole is like a dozen." What does this mean?
   a. A dozen consists of 12 of anything, and a mole also consists of 12 of anything.
   b. A dozen consists of a set number of objects, and a mole also consists of a set number of objects.
   c. A dozen can consist of any object including atoms or molecules (like donuts or pencils), and a mole must consist of atoms or molecules.
   d. A dozen has a set mass of objects, and a mole also has a set mass of objects.
   e. A dozen and a mole refer to the same concept, so the words can be used interchangeably.

6. What is the molar mass of sodium sulfate?
   a. 55.06 g/mol
   b. 78.05 g/mol
   c. 119.06 g/mol
   d. 142.04 g/mol
   e. 215.13 g/mol

7. What is the mass of 0.185 moles of liquid water?
   a. 0.0103 grams
   b. 0.0109 grams
   c. 3.15 grams
   d. 3.33 grams
   e. 97.4 grams

8. In your lab class, you calculated that the piece of aluminum foil you had been given contained 3.01×10^{22} atoms of aluminum. What was the mass of the piece of foil?
    a. $1.85x10^{-3}$ grams Al
    b. 0.0500 grams Al
    c. 1.35 grams Al
    d. 5.00×10^{44} grams Al
    e. 1.35×10^{46} grams Al

9. How do the number of atoms in a 1.0 mole sample of argon gas compare to the number of atoms in a 1.0 mole sample of oxygen gas? Select the answer that completes the sentence below.

    The number of atoms in 1.0 mole of argon gas is _____ the number of atoms in 1.0 mole of oxygen gas.

    a. one-quarter
    b. half
    c. the same as
    d. double
    e. four times as great as

10. A compound consisting of both nitrogen and oxygen is 30.4% nitrogen by mass. The molecular formula of the compound has twice the molar mass of the empirical formula of the compound. What is the molar mass of the **molecular formula** of the compound?
    a. 30.00 g/mol
    b. 46.00 g/mol
    c. 60.00 g/mol
    d. 92.00 g/mol
    e. 130.0 g/mol

11. A sample consisting of 2.0 moles of nitrogen gas are present at a pressure of 2,280 torr and a temperature of 300 K. What is the volume of this gas sample?
    a. 0.0216 L
    b. 0.244 L
    c. 16.4 L
    d. 31.3 L
    e. 144 L

12. A gaseous hydrocarbon occupies 50.0 L of space at pressure of 1.50 atm and room temperature of 298 K. If this gas sample has a mass of 89.0 grams, what is the identity of the hydrocarbon making up the gas?
    a. C_3H_8
    b. C_2H_5
    c. CH_4
    d. CH_3
    e. CH_2

13. Liquid nitrogen is poured on a helium balloon and cools it from room temperature (25.0°C) to -196°C. How does the size of the balloon at room temperature compare to the size of the balloon after it has been cooled by the liquid nitrogen?

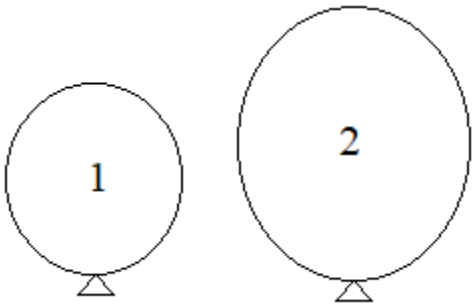
    The balloon is about _____ as large after the liquid nitrogen is poured on it compared to before the liquid nitrogen was poured on it.

    a. Four times
    b. Twice
    c. One-half
    d. One-third
    e. One-quarter

14. An aerosol can (as shown in lecture) is kept at a room temperature of 296 K and has an internal pressure that matches that of the air at 3.00 atm. When the can is heated to a new temperature of 373 K, what is the new pressure in the can?
    a. 0.690 atm
    b. 2.38 atm
    c. 2.89 atm
    d. 3.78 atm
    e. 13.0 atm

Please go on to the next page.

15. Recall the demonstration in lecture in which balloons of two different sizes were shown and compared. Balloons 1 and 2 pictured below are in the same space but different sizes. Compare the pressures and number of moles of gas in each of the balloons by selecting the correct answer below.



	Number of moles of gas	Pressure
a.	1 = 2	1 = 2
b.	2 > 1	2 > 1
c.	1 > 2	1 > 2
d.	2 > 1	1 > 2
e.	2 > 1	1 = 2

Please go on to the next page.

Part 2: Free Response

16. Please thoroughly answer the questions in the space below, showing all work where applicable.

a. A 10.0 gram sample of compound #1 consists of 8.00 grams sulfur and the rest oxygen. Its empirical and molecular formulas are the same. Give the formula and name of the compound. Show your work in the space below.

Compound #1 Formula	Compound #1 Name

b. Compound #2 consists of an unknown X element and oxygen which combine to have the formula X_2O. This compound is 11.2 % oxygen by mass. Identify the unknown element, and use it to give the formula and give the name of the compound. Show all work in the space below:

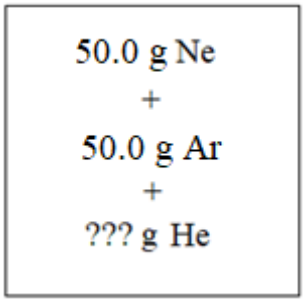
Compound #2 Formula	Compound #2 Name

c. Compound #3 consists of an ionic compound which is formed between an alkaline earth metal and the element whose atoms each contain 17 protons. The molar mass of this compound is 158.626 g/mol. Identify the unknown element and use it to give the formula and name of the compound. Show all work in the space below.

Compound #3 Formula	**Compound #3 Name**

Please go on to the next page.

17. A sealed, rigid container holds a mixture of 50.0 grams of neon gas, 50.0 grams of argon gas, and some mass of helium gas. Answer the questions regarding the contents of this container below.



Fill in each of the blanks in all parts of this this problem with "greater than", "less than," or "equal to." In the space below each question, thoroughly explain why you filled in the blanks the way you did.

a. Compare the temperature of the neon gas to the temperatures of the argon and helium gases and explain.

- ***The temperature of the neon gas is _____ the temperature of the argon gas.***
- ***The temperature of the neon gas is _____ the temperature of the helium gas.***

b. Compare the volume of the neon gas to the volumes of the argon and helium gases, then explain. Be sure your explanation addresses particle behavior.

- ***The volume of the neon gas is _____ the volume of the argon gas***
- ***The volume of the neon gas is _____ the volume of the helium gas.***

c. Compare the partial pressure of the neon gas to the partial pressure of the argon gas. Justify your answer below by both explaining and showing mathematical support.

The partial pressure of the neon gas is _____ the partial pressure of the argon gas.

d. The total pressure of all three gases in this container is 6.00 atm. The partial pressure of the neon gas is 2.00 atm. Use this information to compare the partial pressure of the neon gas to the partial pressure of the helium gas. Justify your answers by showing work and giving the partial pressures of all three gases.

The partial pressure of the neon gas is _____ the partial pressure of the helium gas.

e. How does the mass of the neon gas compare to the mass of the helium gas? Fill in the blank and then explain in the space below by showing mathematical support, including giving the mass of helium gas present.

The mass of the neon gas is _____ the mass of the helium gas.

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