CHEMISTRY 101
Hour Exam I
February 12, 2019
McCarren

Name _____

Signature _____

Section _____

"Positive thinking is more than just a tagline. It changes the way we behave. And I firmly believe that when I am positive, it not only makes me better, but it also makes those around me better." — Harvey Mackay

This exam contains 17 questions on 9 numbered pages. Check <u>now</u> 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)	_____

<u>Useful Information</u>:

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).

Section 1: Multiple Choice – Select the best answer.

1. Which substance is not correctly matched with its identity?
    a. Water – compound
    b. Sodium chloride – heterogeneous mixture
    c. Helium – monatomic element
    d. Air – homogenous mixture
    e. Oxygen – diatomic element

2. Choose the answer to this question that is correct and which *also* provides a correct explanation.

    Some elements can be considered molecules, and all compounds are considered to be molecules. Can an element ***also*** be called a compound?

    a. Yes: Both an element and a compound can contain more than one atom bonded together.
    b. Yes: It is possible to break apart a compound through a chemical change and be left with elements.
    c. It depends: An element can be considered a compound only if it consists of multiple atoms bonded together.
    d. No: Compounds must always contain at least one metal atom and some elements are nonmetals.
    e. No: An element must have only one type of atom and compounds must have different types of atoms.

3. Consider the ionic compound XCl_2 where X represents some unknown element. Which could **not** be a possible name for the compound XCl_2?
    a. Calcium chloride
    b. Magnesium chloride
    c. Manganese(II) chloride
    d. Sulfur dichloride
    e. Copper(I) chloride

4. Consider an aluminum ion with formula below:

$$^{27}_{13}Al^{+3}$$

    Which of the following has the same number of **protons** as this ion?
    a. A neutral atom of aluminum.
    b. A neutral atom of neon.
    c. A stable ion of fluorine.
    d. Two of the above (a.-c.) have the same number of protons as this ion.
    e. All of the above (a.-c.) have the same number of protons as this ion.

5. What is the molar mass of strontium carbonate? Choose the closest answer.
    a. 99.63 grams
    b. 146.5 grams
    c. 147.6 grams
    d. 187.2 grams
    e. 235.2 grams

6. You have a one-mole sample of each of the following. Which sample contains the greatest number of oxygen atoms?
    a. 1.0 mole sodium hydroxide
    b. 1.0 mole calcium nitrate
    c. 1.0 mole potassium oxide
    d. 1.0 mole lithium phosphate
    e. 1.0 mole ammonium sulfate

7. How many oxygen atoms are present in a 10.0 mole sample of oxygen gas?
    a. 10.0 atoms oxygen
    b. 320. atoms oxygen
    c. 3.76×10^{23} atoms oxygen
    d. 6.02×10^{24} atoms oxygen
    e. 1.20×10^{25} atoms oxygen

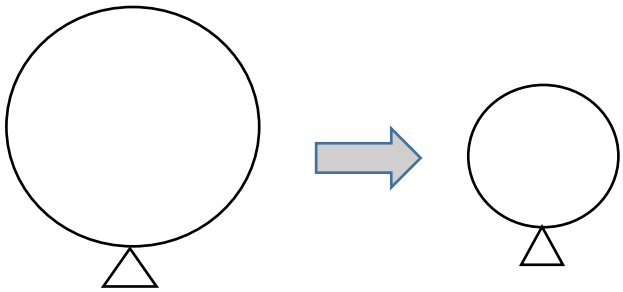
In the first part of your "Empirical and Molecular Formula" lab activity, you measured the mass of a piece of aluminum foil and calculated the number of atoms it contained. Use this idea to answer the next two questions.

8. You have a 2.50-gram sample of aluminum foil. What mass of copper would have the same number of atoms as this aluminum foil?

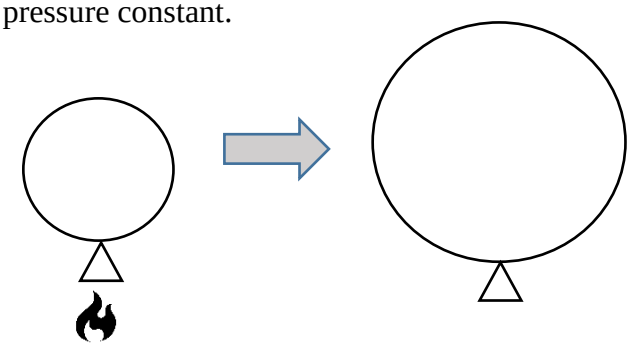
    a. 0.393 grams Cu
    b. 0.0928 grams Cu
    c. 1.06 grams Cu
    d. 5.90 grams Cu
    e. 159 grams Cu

9. You have a sheet of foil of a different element which you determined to contain 3.0×10^{23} atoms. The sample of this sheet has a mass of 32.7 grams. What is the sheet of foil made of?
    a. Zinc
    b. Copper
    c. Nickel
    d. Sulfur
    e. Iron

10. A weather balloon with volume 300 liters contains 15.0 moles of argon gas. Argon is removed from the balloon until its volume is one-third of what it was before. How many moles of argon **<u>were removed from</u>** the balloon? Assume the balloon adjusts its volume to maintain constant pressure. The temperature of the balloon is constant.
    a. 2.50 moles
    b. 5.00 moles
    c. 10.0 moles
    d. 15.0 moles
    e. 20.0 moles



11. The balloon, which was at 300 K, is placed in a large oven and reheated until its volume is again 300 L. To what Celsius temperature was the balloon heated? Assume the balloon does not pop and adjusts to keep the pressure constant.
    a. 900°C
    b. 627°C
    c. 450°C
    d. 177°C
    e. 81°C

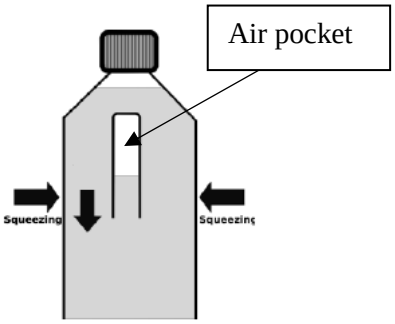


12. What is the volume of a 1.50 mole sample of nitrogen gas at a pressure of 2.0 atm and a temperature of 297 K?
    a. 512 L
    b. 36.6 L
    c. 18.3 L
    d. 1.48 L
    e. 0.546 L

13. Which of the following is **<u>not</u>** an assumption we make about ideal gases and their behavior according to kinetic molecular theory?
    a. Gas particles are in constant random motion.
    b. While the gas itself may take up significant space, the volume of the gas particles themselves do not take up significant space.
    c. A gas sample of neon and a gas sample of helium would have the same average kinetic energy as long as the two gases are at the same temperature.
    d. There are strong forces of attraction between separate gas particles.
    e. <u>All of the above</u> are assumptions that we make about ideal gases and their behavior according to kinetic molecular theory.

14. Recall from the second lab when you saw the water bottle filled with the "diver." Squeezing the diver forced it to sink to the bottom of the water bottle. Consider the air pocket in the diver. As the diver was squeezed, the density of the air in the pocket increased. How did squeezing the bottle affect the mass and volume of gas in the air pocket of the diver?

	Mass of gas in diver air pocket	Volume of gas in diver air pocket
a.	Constant	Decrease
b.	Constant	Increase
c.	Decrease	Increase
d.	Increase	Decrease
e.	Decrease	Decrease



15. A rigid steel tank holds 20.0 grams of helium gas at some temperature. The pressure of the helium in the container is 10.0 atm. 20.0 grams of neon gas is added to the container. What is the total pressure in the container after the neon gas is added?
    a. Less than 10.0 atm
    b. Exactly 10.0 atm
    c. Between 10.0 atm and 20.0 atm
    d. Exactly 20.0 atm
    e. Greater than 20.0 atm

Please go on to the next page.

Section 2: Free Response – Please write your answers in the space below.

16. Consider the two compounds dinitrogen tetroxide and dinitrogen pentoxide.

a. Give the formulas for each of these substances.

Dinitrogen tetroxide –

Dinitrogen pentoxide -

b. Though these compounds have similar names, the empirical formula and the molecular formula are the same for only one of the compounds. For the other compound, the empirical and molecular formulas are different from each other. Which substance has the same empirical and molecular formula? Explain why.

You find a third compound containing only nitrogen and oxygen that is 69.6% oxygen by mass with a molar mass of 138.0 g/mol. Use this compound to answer parts c. and d.

c. Give the empirical formula of this compound, showing all necessary work and calculations. Does this compound have the same empirical formula as either of the compounds in part a)? If so, identify which one. If not, explain why not.

Please go on to the next page.

16. (continued)

d. Give the molecular formula of this compound, showing all necessary work and calculations. Does it have the same molecular formula as either of the compounds in part a)? If so, identify which one, showing all necessary work and calculations to support your answer. If not, explain why not.

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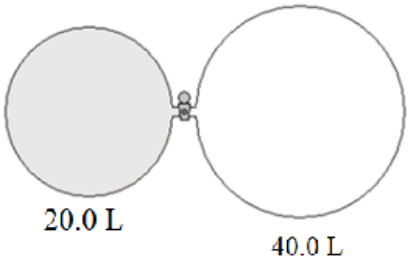
17. Consider a two-bulb container in which the bulbs are connected by a valve. The valve is closed so that gas is unable to move between the two bulbs.



The right 40.0 L bulb currently holds a sample of some noble gas "X" at a temperature of 31.5°C and a pressure of 3.75 atm.

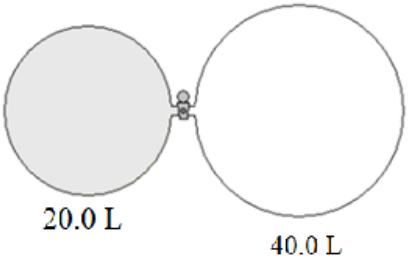
a. How many moles of gas are present in the container?

b. The mass of gas in the right side of the container is 240.0 grams. What is the identity of noble gas X?

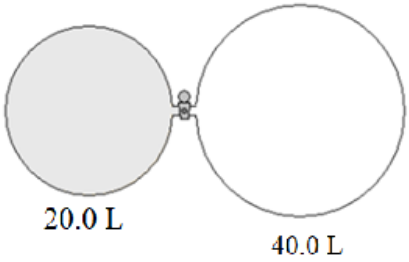
c. The valve between the two bulbs is opened so that the gas is able to flow freely between the two bulbs. When this happens, the number of gas particles in the container remains constant, though the gas particles arrange themselves in the container differently.

Using a dot (·) to represent one mole of gas, fill in the diagram below to show how gas particles are arranged before the valve is opened and again some time after the valve is open.

Before opening valve



After opening valve



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d. Though the moles of gas in the container stayed the same after opening the valve, were there changes to other properties of the gas? Determine whether the volume of the gas, pressure of the gas, and temperature of the gas increased, decreased, or stayed the same as a result of opening the valve. Explain your reasoning for each variable. **If the variable changed, your explanation must include a description of particle behavior.**

Variable	**Increase, decrease, or constant?**	**Explanation**
Total volume of gas X sample		
Total pressure of gas X sample		
Temperature of gas X sample		

e. For any variable you said changed above, calculate the value of the new quantity after the valve has been opened. Give your answers in the table below. Clearly show all work below the table. If the value stayed constant, you may write "constant" in the table.

	Before valve is opened	**After valve is opened**
Volume of gas sample	40.0 L	
Pressure of gas sample	3.75 atm	
Temperature of gas sample	31.5°C	

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