CHEMISTRY 101
Hour Exam I
February 9, 2017
Dr. D. DeCoste

Name _____

Signature _____

T.A. _____

This exam contains 17 questions on 6 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:

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

$PV = nRT$

$R = 0.08206$ Latm/molK

$K = °C + 273$

Avogadro's number = 6.022×10^{23}

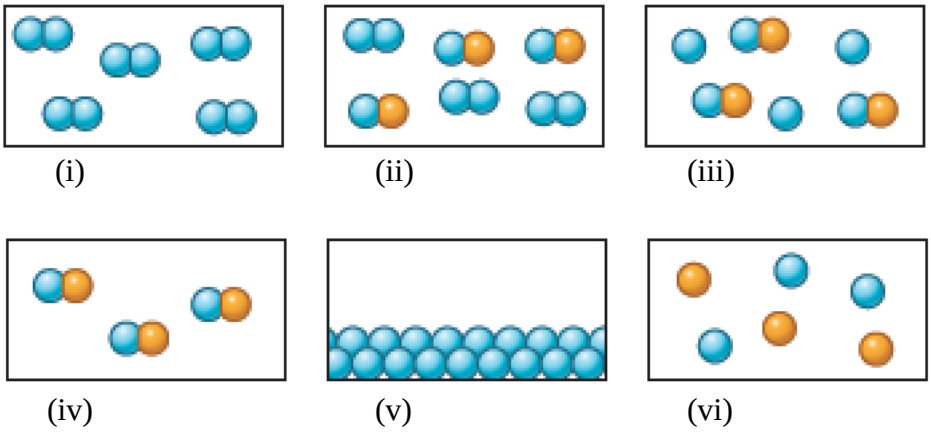
1. You measure a rectangular swimming pool and find its length to be 42.83 m and its width to be 9.572 m. With these measurements determine the **perimeter** of the garden in meters (m) reported to the correct number of significant figures.

a) 104.8 m b) 105 m c) 104.80 m d) 110 m e) 104.804 m

2. An ion has a charge of 2+ and 28 electrons. From which atom does this ion come?

a) Si b) Cr c) Fe d) Ni e) Zn

3. Consider the following "microscopic" pictures below.



How many of these pictures include elements, but no compounds?

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

4. How many of the following has been named **correctly**?

I. FeS: iron(II) sulfide
II. SF_6: sulfur hexafluoride
III. PbO_2: lead(IV) oxide
IV. $(NH_4)_3PO_4$: ammonium phosphate

a) 0 b) 1 c) 2 d) 3 e) 4

5. A compound mislabeled "phosphorus oxide" is known to be 43.6% phosphorus by mass. You also know that the molecular formula has a molar mass twice that of the empirical formula. What is the molecular formula for this compound?

a) PO_3 b) P_2O_6 c) PO_4 d) P_2O_8 e) P_4O_{10}

6. What is the molar mass of potassium sulfate (all in g/mol)?

a) 71.17 b) 110.27 c) 135.17 d) 174.27 e) 231.24

7, 8. You have samples of water (H_2O) and ammonia (NH_3) which have the **same mass** and there are 0.125 mol of water.

7. How many moles of ammonia are in the sample?

a) 0.118 mol b) 0.125 mol c) 0.129 mol d) 0.132 mol e) 0.151 mol

8. What is the mass of the water sample?

a) 1.25 g b) 2.13 g c) 2.25 g d) 4.50 g e) 18.0 g

9, 10. Consider 100.0 g samples of carbon dioxide, iron(III) oxide, and sodium sulfate.

9. Which sample has the **greatest number** of oxygen atoms?

a) carbon dioxide
b) iron(III) oxide
c) sodium sulfate
d) They all contain the same number of oxygen atoms.

10. Which sample has the **least number** of oxygen atoms?

a) carbon dioxide
b) iron(III) oxide
c) sodium sulfate
d) They all contain the same number of oxygen atoms.

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11. Consider three identical steel tanks each filled with 40.0 g of argon (Ar) gas at 25.0°C. The pressure in each of the tanks is changed in different ways as described below:

- An additional 40.0 g of argon gas is added to tank #1 at constant temperature.
- A 25.0-g sample of neon (Ne) gas is added to tank #2 at constant temperature.
- The temperature of tank #3 is increased to 50.0°C.

Which of the following statements is true after the pressure is changed in each of the tanks?

a) The pressure in tank #1 is the highest.
b) The pressure in tank #2 is the highest.
c) The pressure in tank #3 is the highest.
d) The pressure in each of the tanks is the same after the changes.
e) The pressure in two of the tanks is equally high.

12. Consider 2 steel containers with the **same volume**, at the **same temperature**. You have 25.0 g of argon gas (Ar) in one of the tanks, and note the pressure to be 1.00 atm. You add 20.0 g of a different gas to the other tank, and note the pressure to be 2.00 atm. Which of the following could be the other gas?

a) CH_4 b) N_2 c) He d) Cl_2 e) CO_2

13. A 20.0-g sample of a gaseous hydrocarbon (a compound consisting of only carbon and hydrogen) is placed in a balloon at 1.00 atm and 25°C. The volume of the balloon is 16.3 L. Determine the molecular formula for this compound.

a) CH_3 b) C_2H_6 c) CH_4 d) C_3H_8 e) C_3H_9

14. Consider two samples of helium gas at the **same pressure and volume**. Sample A is at 100K and sample B is at 200K. How does the number of moles of gas in the samples compare?

a) There are a greater number of moles of helium gas in sample A.
b) There are a greater number of moles of helium gas in sample B.
c) There are an equal number of moles of helium gas in each sample
d) We need to know the pressure and volume to answer this question.

15. A sample of gas at 38°C occupies a volume of 2.97 L and exerts a pressure of 3.14 atm. The gas is heated to 118°C and the volume is decreased to 1.04 L. Determine the new pressure exerted by the gas.

a) 0.875 atm b) 2.89 atm c) 7.13 atm d) 11.3 atm e) 92.3 atm

16. As part of these questions, you will have to determine the identity of a metal in a given compound. **Show all work and explain** when needed.

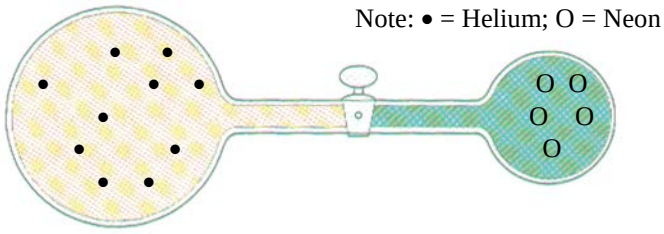
    a. A ionic compound has the formula MCO_3 and the metal ion has 27 electrons. Determine the **identity of the metal (name and symbol)** and **name the compound**. Full credit is reserved for **complete support and a thorough explanation.**

- The carbonate ion has a 2– charge, and since the formula is MCO_3, the charge of the metal ion must be 2+.
- Since the metal ion has 27 electrons, and the metal lost two electrons, the neutral metal atom must have had 29 electrons.
- Since the neutral metal atom had 29 electrons, the metal must have 29 protons, so it is **copper (Cu)**.
- Since copper is a transition metal and can have more than one charge, we must use a Roman numeral to name it.
- Since the copper ion has a 2+ charge, the name is **copper(II) carbonate**.

    b. A metal in Column 2A is part of an ionic compound with an oxygen ion. This metallic oxide is 60.31% by mass metal. Determine the **identity of the metal (name and symbol)** and the **identity of the compound (name and formula)**. Full credit is reserved for **complete support and a thorough explanation.**

- The oxide ion has a 2– charge.
- Group 2 metal ions have a 2+ charge
- The formula for the compound must be MO.
- $\frac{M}{M+O} = \frac{M}{M+16.00} = 0.6031$
- Solving for M, we get 24.31.
- Atomic mass of M = 24.31, which is **magnesium, Mg**.
- Compound is **magnesium oxide, MgO**.

17. Consider the following diagram in which each symbol (• or O) represents 1 mole of the gas:



Volume = 400.0-L Volume = 100.0-L

a. Which is greater, the initial pressure of helium or the initial pressure of neon? How much greater? **Show and explain all work to support your answer.**

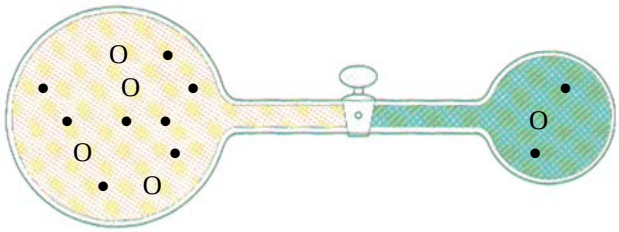
The pressure of _____ is greater by a factor of _____.
(helium/neon) (number)

Since T is the same, P is related to n/V. For helium, this is 10/(400), and for neon this is 5/100.

Thus, P(He)/P(Ne) = [10/(400)]/[5/100] = 1000/2000 = ½

The pressure of neon is greater by a factor of 2.

b. Assuming the connecting tube has negligible volume, **show what this system will look like after the stopcock between the two flasks is open**. Temperature remains constant. **Explain your answer.**



Gases spread out evenly based on volume so there should be 4 times as many particles in the 400 L side as the 100 L side.

17. (con't)

c. After the stopcock is open, determine the **final partial pressure of neon** in terms of the initial pressure of neon. Assume constant temperature. **Show and explain all work to support your answer.**

The pressure of neon _____ by a factor of _____.
(increases/decreases) (number)

P(Ne; init) is related to 5/100 (from before)

P(Ne; final) is related to 5/(500)

Thus P(Ne; final) / P(Ne; init)= [5/(500)]/[5/100] = 100/500 = 1/5

The pressure of neon decreases by a factor of 5.

d. Suppose the **initial pressure of helium** (before the stopcock is open in part "a") is **0.700 atm**.

i. Determine the temperature of the gases in °C. **Show all work to support your answer.**

PV=nRT; T = PV/nR

T = (0.700atm)(400.0L)/(10mol)(0.08206Latm/molK) = 341 K

T = 341 K = **68°C**

ii. Determine the total pressure (in atm) in the container after the stopcock is open (see part "b"). **Show all work to support your answer.**

PV=nRT; P = nRT/V

P = (15mol)(0.08206Latm/molK)(341K)/(500.0L) = **0.839 atm**