CHEMISTRY 101
Hour Exam I
September 20, 2016
Adams/Huynh

Name _____

Signature _____

Section _____

"Beset by a difficult problem? Now is your chance to shine. Pick yourself up, get to work and get triumphantly through it."

--Ralph Marston--

This exam contains 17 questions on 7 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	(15 pts.)	_____
17	(15 pts.)	_____
Total	(60 pts)	_____

<u>Useful Information</u>:

PV = nRT

R = 0.08206 L•atm/mol•K

Avogadro's number = 6.022×10^{23}

1 L = 1 dm^3

1 mL = 1 cm^3

1 atm = 760. torr

1 Mg = 1×10^6 g

K = °C + 273

Density = mass / volume

Volume = length × width × height

1 L = 1000 mL

1 g = 1000 mg

1 m = 100 cm

STP = standard temperature and pressure = 0°C and 1.00 atm

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

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

1. Calculate the mass percent of oxygen in calcium carbonate (also known as blackboard chalk)?

   a) 23.50% b) 34.24% c) 38.05% d) 47.96% e) 59.96%

2. Which of the following substances is/are homogeneous mixtures?

   I. helium
   II. pure ice
   III. vegetable soup
   IV. air (in this room)
   V. soil (dirt)

   a) I and IV
   b) IV and V
   c) II and III
   d) II only
   e) IV only

3. What is the empirical formula for $Al_2(HPO_4)_3$?

   a) $Al(HPO_4)$
   b) $Al_4(HPO_4)_6$
   c) $Al_2(HPO_4)_3$
   d) $Al_2(HPO_4)$
   e) $Al_3(HPO_4)_2$

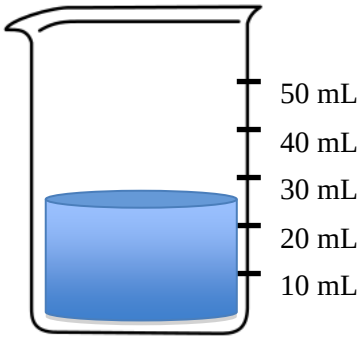
4. Which of the following statements is **false** according to Dalton's atomic theory?

   a) An atom of argon can be broken down into smaller particles that will still have unique properties of argon.
   b) Atoms combine in simple whole number ratios to form compounds.
   c) All atoms of chlorine have identical properties that distinguish them from other elements.
   d) Atoms of sodium do not change into another element during a chemical reaction with chlorine.
   e) H_2O_2 consists of 16 g of oxygen for every 1 g of hydrogen.

5. What is the molar mass of cobalt(III) sulfate?

   a) 155.00 g/mole
   b) 326.07 g/mole
   c) 358.07 g/mole
   d) 368.93 g/mole
   e) 406.07 g/mole

6. You take 20.0 mL of water from a graduated cylinder and **add it to the beaker containing the water below**. What is the new volume of water in the beaker? Choose the best answer.



a) 40 mL b) 40. mL c) 45 mL d) 45.0 mL e) 50 mL

7. The volume occupied by 0.3576 g of a gas at 100.0°C and 712 torr was determined to be 265 mL. What is the identity of the gas?

a) BH_3 b) HF c) H_2 d) O_2 e) C_3H_8

8. Which of the following has the **most** moles of substance?

a) 5.0 g Fe
b) 5.0 g He
c) 5.0×10^{23} atoms Ne
d) 5.0×10^{-2} mol B
e) 5.0 mg Ca

9. A certain ion has 27 electrons and 34 neutrons. Which of the following correctly identifies both the ion and its mass number?

	Ion	***Mass Number***
a)	Cu^{2+}	63
b)	Cu^{2+}	61
c)	Co^{2+}	61
d)	Co^{2+}	59
e)	Se^{2-}	61

10. If the pressure of a gas doubled while the temperature changed from 150.°C to 5°C, what change was also observed? (Assume the moles of gas are constant.)

a) The volume of the gas doubled.
b) The volume of the gas decreased to about one-third of its original value.
c) The volume of the gas increased to about three times its original value.
d) The volume of the gas decreased to about half its original value.
e) The volume of the gas did not change.

11. Which of the following statements is/are an example of a chemical property?

    a) Ice melts above 0°C.
    b) Lead is denser than aluminum.
    c) Oxygen gas is consumed in the burning of wood.
    d) Table salt (sodium chloride) is soluble (dissolves) in water.
    e) At least two of the above are examples of a chemical property.

Consider the following substance to answer questions 12 and 13: A hydrocarbon contains 82.66% carbon and the rest is hydrogen.

12. Determine the empirical formula of the compound.

    a) CH_3 b) C_7H_{17} c) CH_2 d) C_2H_5 e) $C_{83}H_{17}$

13. If the ratio of the molar mass to the empirical formula molar mass is 2:1, what is the molecular formula of the compound?

    a) $CH_{2.5}$ b) C_2H_6 c) CH_4 d) C_4H_{10} e) C_7H_{17}

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14. How many atoms of phosphorus are in 175 g P_4O_{10}?

    a) 1.48×10^{24} atoms
    b) 3.71×10^{23} atoms
    c) 9.77×10^{23} atoms
    d) 9.28×10^{22} atoms
    e) 3.71×10^{24} atoms

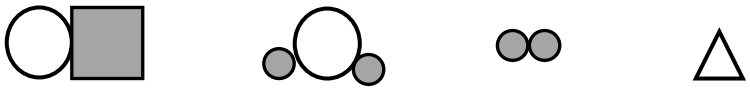
15. A rigid container has a mixture of He, Ne, and Ar at a total pressure of 1.6 atm. It is found to contain 0.55 mol He, 0.94 mol Ne, and 0.35 mol Ar. What is the partial pressure (in atm) of each gas?

	He	**Ne**	**Ar**
a)	0.55	0.94	0.35
b)	0.48	0.82	0.30
c)	5.4	3.1	8.4
d)	1.1	0.66	1.3

    e) Cannot be determined without the temperature or volume of container

Answer the questions below. Show all work! Only complete and coherent explanations will receive full credit. **Please limit your answers to the space provided.**

16. a) Consider the following microscopic, molecular representations below (representing compounds and/or elements):



Use the microscopic drawings above to show the following:

(i) a solid element

(ii) a gaseous compound

(iii) a mixture of a compound with a molecular element

b) A perfect cube of unknown elemental composition has a length of 1.40 m on each side. The mass of the cube is 21.57 Mg (megagrams). The following density table is available:

Elemental Substance	Au	Fe	Pt	Ti	Cu	Ag	Pb
Density (g/mL)	19.3	7.86	21.4	4.51	8.96	10.5	11.4

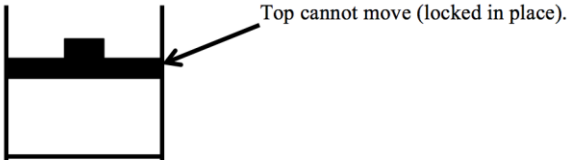
Determine the metal used to prepare the cube. Show all work.

c) Recall from lab when you placed a drinking straw vertically into a cup that was half-filled with water. When you placed your finger completely over the opening of the straw and took the straw out of the water, the water should have stayed in the straw with the exception of one water droplet suspended at the bottom (or it may have even fell back into the cup). Why did the water remain in the straw? Be very complete in your explanation (including the four variables P, V, n, and T). Be sure to discuss what's happening to the gas particles inside the straw.

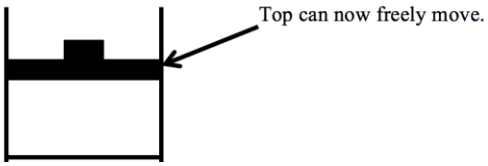
(Continue on to #17 on the next page.)

17. A syringe contains 589 mL of carbon monoxide gas at 325 K and 1.20 atm of pressure. A second syringe contains 473 mL of nitrogen gas at 298 K and 2.60 atm.

a) What is the final pressure if the contents of these two syringes are injected into an empty, locked (immoveable) piston with a volume of 1.15 L and a temperature of 245 K?



b) The piston is now unlocked so that the top can freely move. Will the volume of the gases inside the piston increase, decrease, or stay the same? Explain your answer.



(Continue on to #17c-d on the next page.)

c) Based on your answers to (a) and (b), what will be the new volume of the gas after the piston is unlocked? In other words, verify (b) mathematically.

d) Throughout this scenario, we assumed that the gases behaved ideally. Under what conditions do gases behave most ideally (address temperature, pressure, and volume)? Why?