

CHEMISTRY 101
Hour Exam I
February 18, 2020
McCarren

Name _____ KEY _____

Signature _____

Section _____

“If you can’t fly then run, if you can’t run then walk, if you can’t walk then crawl, but whatever you do you have to keep moving forward.”

– Dr. Martin Luther King Junior

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:

$$PV = nRT$$

$$K = ^\circ C + 273$$

$$R = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$$

$$\text{Density} = \text{mass} / \text{volume}$$

$$\text{Avogadro's number} = 6.022 \times 10^{23}$$

$$1 \text{ L} = 1000 \text{ mL}$$

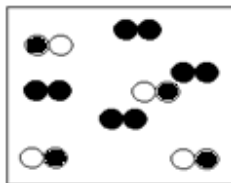
$$1 \text{ atm} = 760. \text{ torr}$$

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. Which best describes the contents of the container below? Choose the answer which best fills in both blanks.



This container holds a _____ which consists of _____.

- a. **mixture; an element and a compound**
 - b. mixture; two compounds
 - c. mixture; two elements
 - d. pure substance; a compound
 - e. pure substance; an element
2. Which of the following formulas is **incorrect** for the given name?

	Name	Formula
a.	carbon tetrachloride	CCl_4
b.	aluminum oxide	Al_2O_3
c.	iron(II) sulfate	FeSO_4
d.	<u>magnesium phosphate</u>	<u>Mg_3P_2</u>
e.	tetraphosphorus decoxide	P_4O_{10}

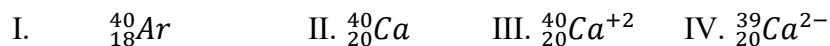
3. Which of the following is **not** correctly paired with its molar mass? Note that molar masses have been rounded to two decimal places.

	Substance	Molar mass
a.	water	18.02 g/mol
b.	copper metal	63.55 g/mol
c.	fluorine gas	37.98 g/mol
d.	<u>chlorine gas</u>	<u>34.45 g/mol</u>
e.	xenon gas	131.30 g/mol

4. How many of the substances from the question #3 consist of particles that can be classified as compounds?
- a. **1**
 - b. 2
 - c. 3
 - d. 4
 - e. 5 (All substances have particles that are molecules.)

5. The distance between Chicago and Los Angeles is about 2,000 miles. If you are driving a car which gets 30 miles per gallon, and gas costs approximately \$3.00 per gallon, about how much will it cost you to make the full trip?
- \$20
 - \$200**
 - \$400
 - \$600
 - \$20,000
6. A 5.00 grams sample of a compound contains 2.82 grams phosphorus and the rest oxygen. Select the correct name for the empirical formula of this compound.
- Phosphorus monoxide
 - Diphosphorus monoxide
 - Diphosphorus tetroxide
 - Phosphorus dioxide
 - Diphosphorus trioxide**
7. The molecular formula of a compound containing only carbon and hydrogen has a molar mass of 78.11 g/mol. Which is a possible empirical formula for this compound?
- CH₅
 - CH₄
 - CH₃
 - CH₂
 - CH**
8. Consider samples of iron(II) oxide, copper(I) oxide, and lithium oxide. Rank these from lowest to highest mass percent of oxygen within each sample.
- iron(II) oxide < copper (I) oxide < lithium oxide
 - copper(I) oxide < iron(II) oxide < lithium oxide**
 - lithium oxide < iron(II) oxide < copper(I) oxide
 - copper(I) oxide < lithium oxide < iron(II) oxide
 - iron(II) oxide < lithium oxide < copper(I) oxide

9. Which of the following **two** choices have the same number of electrons?



- a. I and II
- b. II and III
- c. II and IV
- d. I and IV
- e. **I and III**

10. A gas in a closed container at constant temperature occupies a volume of 6.75 L and exerts a pressure of 842 torr. What volume (in L) will the gas occupy at a pressure of 662 torr?

- a. 0.012 L
- b. 5.30 L
- c. **8.58 L**
- d. 50.5 L
- e. 82,600 L

11. What is the pressure of a 50.0 L tank of gas containing 60.0 grams of argon (Ar) at a temperature of 25°C?

- a. 0.0620 atm
- b. **0.734 atm**
- c. 1.35 atm
- d. 2.46 atm
- e. 29.3 atm

12. Consider the “hand boiler” experiment from the “Explorations with Gases” lab activity. Which of the following is **false** about this experiment?

- a. Your hand increased the temperature of the gas within the boiler.
- b. The gas particles moved faster when your hand was touching the boiler.
- c. More particles moved into the gas phase when your hand was touching the boiler.
- d. The liquid moved up into the tube because the gas particles put pressure outside of the liquid.
- e. **The gas particles themselves got bigger which pushed the liquid down.**

13. A sealed, rigid container holds a mixture of 5.00 moles of helium gas. The helium gas exerts a pressure of 1.50 atm on the walls of the container. 5.00 moles of argon gas at the same temperature is added to the container. What is the total pressure in the container after the argon gas has been added?

- a. Exactly 1.50 atm
- b. Between 1.50 atm and 3.00 atm
- c. **Exactly 3.00 atm**
- d. Between 3.00 atm and 4.50 atm
- e. Greater than 4.50 atm

5.00 moles of Ar
+
5.00 moles of He

14. Another sealed, rigid container holds a mixture of 40.0 grams of helium and 40.0 grams of argon gases at the same temperature. How do the partial pressures of the gases compare?

- a. The partial pressures are equal.
- b. The partial pressure of helium is twice the partial pressure of argon.
- c. The partial pressure of argon is twice the partial pressure of helium.
- d. **The partial pressure of helium is ten times greater than the partial pressure of argon.**
- e. The partial pressure of argon is ten times greater than the partial pressure of helium.

40.0 grams Ar
+
40.0 grams He

15. A balloon contains 12.0 grams of helium gas at some temperature and pressure. Which of the following changes would double the volume of the balloon?

- a. Increasing the temperature in Celsius from 25°C to 50°C.
- b. Adding 12.0 grams of neon gas to the balloon
- c. **Reducing the pressure outside the balloon from 2.0 atm to 1.0 atm**
- d. Two of these changes double the volume of the balloon
- e. All of these double the volume of the balloon

Please go on to the next page.

Part 2: Free Response

Please clearly write your answers in the spaces below. Be sure to show all work and explain in complete sentences where required.

16. In the “Mole and Empirical Formula” activity, you determined the number of atoms that were present in a piece of aluminum foil. Refer to this activity to answer the related questions below. Show all work, including clearly cancelling units where necessary.

- a. What mass of copper has the same number of atoms as a 10.0 gram sample of aluminum foil?

+3 points

+1

$$10.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} = 0.371 \text{ moles Al}$$

+1

$$0.371 \text{ moles Cu} \times \frac{63.55 \text{ g Cu}}{1 \text{ mol Cu}} = \boxed{23.55 \text{ g Cu}}$$

+1

- b. 88.0 grams of unknown element X contains twice as many atoms as a 10.0 gram aluminum foil sample. What is unknown element X? Show work.

+1

$$10.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} = 0.371 \text{ moles Al}$$

+4 points

+1

$$0.371 \text{ moles Al} \times 2 = 0.743 \text{ mol X}$$

$$\frac{88.0 \text{ g X}}{0.743 \text{ mol X}} = 118.4 \frac{\text{g}}{\text{mol}} \quad \boxed{\text{Tin!}}$$

+1

+1

Please go on to the next page.

In another experiment, you are given two 88.0 grams samples; one consists of carbon dioxide gas and the other consists of propane gas (C_3H_8).

- c. Calculate the number of **molecules** of gas present in each of the samples. You should answer separately for both CO_2 and C_3H_8 .

$$88.0 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.0 \text{ g } CO_2} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol } CO_2} = \boxed{1.20 \times 10^{24} \text{ molecules } CO_2}$$

+1

+1

+4 points

+1

$$88.0 \text{ g } C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.1 \text{ g } C_3H_8} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol } C_3H_8}$$

$$= \boxed{1.20 \times 10^{24} \text{ molecules } C_3H_8}$$

+1

- d. Calculate the number of **atoms of carbon** present in each of the samples. You should answer separately for both CO_2 and C_3H_8 .

$$88.0 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.0 \text{ g } CO_2} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol } CO_2} \times \frac{1 \text{ atom C}}{1 \text{ molecule } CO_2} = \boxed{+1}$$

+4 points

$$= \boxed{1.20 \times 10^{24} \text{ atoms C}}$$

+1

$$88.0 \text{ g } C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.1 \text{ g } C_3H_8} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol } C_3H_8} \times \frac{3 \text{ atoms C}}{1 \text{ molecule } C_3H_8} = \boxed{+1}$$

$$= \boxed{3.65 \times 10^{24} \text{ atoms C}}$$

+1

Please go on to the next page.

17. You are holding three balloons which each contain varying numbers of moles of different noble gases. Compare each of the following properties of the gases below and provide the appropriate support.

Balloon A contains 2.0 moles of neon gas.	Balloon B contains 4.0 moles of helium gas.	Balloon C contains 2.0 moles of argon gas.
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- a. Rank balloons A, B, and C from low to high masses of gas. If two or more of the balloons have equal masses of gas, please state this as well. Give mathematical support for your answers in the space below.

B < A < C

+1 ranking

+3 points

$$2.0 \text{ moles Ne} \times \frac{20.18 \text{ g Ne}}{1 \text{ mol Ne}} = 40.4 \text{ g Ne}$$

$$4.0 \text{ moles He} \times \frac{4.003 \text{ g He}}{1 \text{ mol He}} = 16.0 \text{ g He}$$

$$2.0 \text{ moles Ar} \times \frac{39.95 \text{ g Ar}}{1 \text{ mol Ar}} = 79.9 \text{ g Ar}$$

+1 work

+1 masses

- b. Rank balloons A, B, and C from low to high temperature. If two or more of the balloons have equal temperature, please state this as well. Explain your answer in the space below.

+1 ranking

+3 points

A = B = C. All three balloons are in the same room so they are at the same temperature.

+2 explain

- c. Rank balloons A, B, and C from low to high pressure. If two or more of the balloons have equal pressures, please state this as well. Explain your answer in the space below.

+1 ranking

+2 explain

+3 points

A = B = C. All three balloons are in the same room so they are at the same pressure. The balloons will adjust their sizes so the inside and outside pressures are the same. If all of the balloons are not getting any bigger or smaller, their pressures is the same as the outside pressure which is the same for each of the balloons.

- d. Rank balloons A, B, and C from low to high volume. If two or more of the balloons have equal volume, please state this as well. Explain your answer in the space below and provide mathematical support.

A = C < B

+1 ranking

+3 points

Because the temperature and pressures of the balloons are the same, the only thing that influences the size of the balloon is the number of moles.

+1

Because balloon B has the greatest number of moles it should be double the size of balloons A and C, because they have half as many moles. (Molar mass does not matter in determining size.)

+1

- e. The density of the gas in each of these three balloons is different. In particular, balloon A holding neon gas is denser than balloon B, holding helium gas. To reduce the density of balloon A so that balloons A and B have the same density, would it be necessary to heat or cool balloon A? Explain.

+1

+3 points

It would be necessary to heat balloon A. Density is mass over volume, so increasing the temperature of balloon A would cause its size to increase.

+1

This increase in volume would result in a decrease in density. The mass inside the balloon would remain constant.

+1

Stop!

You have reached the end of the exam! Anything written after this page will not be graded.