## CHEMISTRY 101 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour Exam I

September 22, 2020 Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Leveritt/McCarren

Section \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***“Challenges make you discover things about yourself that you never really knew.”  - Cicely Tyson***

This exam contains 32 questions. The first 15 questions are multiple choice questions. The remaining questions consist of two separate larger problems divided up into parts that link together. You may need to explain, calculate, or show work for answers. Please be sure to complete all questions.

1-15 (30 pts.) \_\_\_\_\_\_\_\_\_

16 (12 pts.) \_\_\_\_\_\_\_\_\_

17 (18 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 × 1023

1 L = 1000 mL

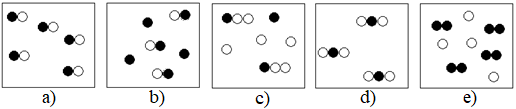
1 atm = 760. torr

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. Which of the following samples does **not** contain a compound? Assume each different colored circle represents an atom of a different element.



1. How many of the following balloons consist of at least one substance that can be considered a molecule?

* A balloon containing sulfur hexafluoride (SF6)
* A balloon containing a mixture of hydrogen and oxygen gases (H2 and O2)
* A balloon containing pure helium (He)
* A balloon containing pure hydrogen gas (H2)

1. 0 (None of these contain substances which can be considered molecules.)
2. 1
3. 2
4. 3
5. 4 (All of these contain substances which can be considered molecules.)
6. Consider an ion of copper with a charge of +1 and a mass number of 65. How many electrons and neutrons are present in this ion?

|  |  |  |
| --- | --- | --- |
|  | Electrons | Neutrons |
| a. | 29 | 65 |
| b. | 28 | 29 |
| c. | 30 | 36 |
| d. | 28 | 36 |
| e. | 30 | 29 |

1. How many of the compounds below are named correctly?

|  |  |
| --- | --- |
| **Formula** | **Name** |
| MgS | Magnesium sulfate |
| Na3N | Sodium nitrate |
| Ca3P2 | Calcium phosphide |
| SO3 | Disulfur trioxide |
| BaCO3 | Barium carbonite |

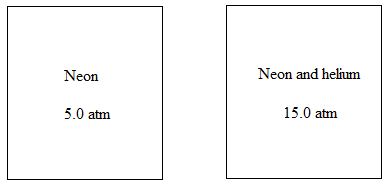
1. 1
2. 2
3. 3
4. 4
5. 5 (All compounds are named correctly.)
6. In lab activity 1, you were told that your TA had brought out a large jar of jelly-beans. You were given an empty jar, a scale, and a few jelly beans and told to estimate the number of beans in the jar without opening or counting. You made the following measurements:

|  |  |
| --- | --- |
| **Measurement** | **Mass** |
| Mass empty jar | 0.200 kg |
| Mass jar full of jelly beans | 1.50 kg |
| Mass of 10 jelly beans | 12.5 g |

Based on these measurements, approximately how many jellybeans are likely to be in the container? Choose the closest answer. (Note: 1 kg = 1000 g)

* 1. 0.100 jelly beans
  2. 500 jelly beans
  3. 1,000 jelly-beans
  4. 5,000 jelly-beans
  5. 10,000 jelly-beans

1. How many moles of aluminum (Al) are present in a 5.0 gram sample of aluminum foil?
   1. 0.0927 moles
   2. 0.185 moles
   3. 26.98 moles
   4. 134.9 moles
   5. 269.8 moles
2. You have samples of **equal masses** of unknown elements A and B. What is **true** about these samples? Assume that element A and element B are different substances.
   1. If the sample of element A has a greater number of atoms, the molar mass of element A must be greater than the molar mass of element B.
   2. If the sample of element A has a greater number of atoms, each atom of element A must contain more neutrons than each atom of element B.
   3. If the sample of element B contains more than twice as many atoms as the sample of element A, the molar mass of element B must be more than double the molar mass of element A.
   4. If the sample of element B has a greater number of atoms, the molar mass of element A must be greater than the molar mass of element B.
   5. Both samples contain an equal number of atoms.
3. Does 1.0 mole of nitrogen gas contain the same number of atoms as 1.0 mole of neon gas? Choose the best answer *and* explanation.
   1. Yes: One mole represents 6.022×1023 “things” so one mole of both contain 6.022×1023 atoms.
   2. Yes: Because nitrogen and neon are both in the gas phase and are likely at the same temperature and pressure, both have the same number of atoms.
   3. No: Each particle of nitrogen gas contains twice as many atoms as each particle of neon gas, so the nitrogen gas sample contains more atoms.
   4. No: The molar mass of nitrogen gas is greater than the molar mass of neon gas, so the nitrogen sample contains more atoms.
   5. Maybe: The gas samples only have the same number of atoms if both samples have the same volume.
4. What is the percent mass of chlorine in one mole of iron(III) chloride?
   1. 17.5%
   2. 34.4%
   3. 38.8%
   4. 55.9%
   5. 65.6%
5. A 10.0 gram sample of a compound consisting solely of sulfur and oxygen contains 4.00 grams of sulfur. What is the empirical formula of the compound?
   1. SO3
   2. S8O
   3. SO2
   4. SO
   5. S4O
6. A compound consisting of only hydrogen and carbon is 92.25% carbon by mass. How many of the following could be the molecular formula for this compound?
   * CH
   * CH2
   * C2H2
   * C2H4
   * C4H4
7. 1
8. 2
9. 3
10. 4
11. 5
12. Boyle’s Law states that as the volume of a gas decreases, the pressure of the gas increases when the moles of gas and temperature are held constant. What happens to the density of a gas sample when the pressure increases according to Boyles Law? (Note: d = m/v)
13. Increases: The mass of the gas particles increases as the pressure increases.
14. Increases: The same mass of gas particles is moving around in a smaller space.
15. Remains constant: No gas has entered or left the container, so the density remains unchanged.
16. Decreases: Increasing the pressure causes some gas to leave the container, decreasing the mass of gas present.
17. Decreases: The gas particles move more slowly after the bottle is squeezed, decreasing the density.
18. A sample of 1.0 moles of argon gas occupies 25.0 liters of space at a pressure of 1.5 atm in a flexible container. What is the temperature (in Celsius) of this gas sample? Assume the argon gas is behaving ideally.
    1. -273 ºC
    2. 25.0 ºC
    3. 31.7 ºC
    4. 184 ºC
    5. 457ºC
19. 1.0 mole of argon gas occupies 25.0 liters of space in a flexible container at a pressure of 1.5 atm. 3.75 moles of neon gas are added to this sample. What is the new volume of the gas mixture? Assume addition of the neon gas does not change the temperature.
    1. 5.26 liters
    2. 6.67 liters
    3. 25.0 liters
    4. 93.8 liters
    5. 119 liters
20. You have a rigid container holding a sample of neon gas. The pressure reading on this container is 5.0 atm. You add helium gas so this sample until the total pressure in the container is 15.0 atm at constant temperature.



What is **false** about the neon and helium gases within the container?

* 1. There are more helium atoms present in the container than neon atoms.
  2. Each neon atom within the gas mixture contains more protons than each helium atom within the gas mixture.
  3. Both the helium and the neon atoms have the same average kinetic energy.
  4. The mass of helium atoms present is greater than the mass of neon atoms present.
  5. The pressure of neon in the container after the helium gas was added is still 5.0 atm.

**Part 2: Free Reponse**

**Part 1**

* 1. Consider the compound dinitrogen tetroxide. Select all compounds below that have the same empirical formula as this compound. Explain how you know.

(choices here)

Multiple choice for compound

* N3O6
* N2O6
* N2O5
* N2O
* NO2

Essay

* 1. Do two compounds with different molecular formulas but with the same empirical formulas have the same percent composition (percent of each element) by mass? Explain why or why not, using your answer(s) above as support. Be sure to provide mathematical support for your explanation.

Radio button with yes/no

Essay

**Part 2**

* 1. Unknown elements X and Z come from the same family (vertical column) and form ionic compounds X2O and Z2O when bonding with oxygen. Which family do elements X and Z come from? Choose an answer and explain:
     1. Alkali metals
     2. Alkaline earth metals
     3. Halogens
     4. Noble gases
     5. Metalloids

Multiple choice

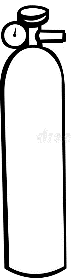
Essay

1. X2O has a greater percent by mass of oxygen than element Z2O. Which element (X or Z) has a greater molar mass? Explain your answer.

Radio button

Essay

Part 2:

Consider a closed, rigid 25.0-liter tank consisting of 5.11 moles of unknown monatomic gas X at 25.0ºC.

* + 1. What is the pressure of the gas in the tank?

Numerical

* + 1. The valve at the top of the tank is opened and some gas is allowed to leave the tank until 4.48 moles of gas are remaining. Determine whether each of the following increased, decreased, or remained constant as the gas left the container.

|  |  |
| --- | --- |
|  | **Increase, decrease, or constant?** |
| Moles of gas in tank | decrease |
| Volume of gas in tank | Matching |
| Pressure of gas in tank |  |
| Temperature of gas in tank |  |

c. For any for each variable from the previous question explain why it changed or remained constant using kinetic molecular theory where applicable. Your explanation should describe any changes in the movement of gas at the particle level.

|  |  |
| --- | --- |
| Volume | Essay |
| Pressure | Essay |
| Temperature | Essay |

1. Give the volume, pressure of gas, and temperature of the gas in the container after the valve was opened. If the value remained constant, please list the same value.

|  |  |  |
| --- | --- | --- |
|  | Before | After |
| Moles | 5.11 moles | 4.48 moles |
| Pressure | (Hint! You solved for this part in the beginning of the problem. Use it to answer the rest of this question.) | numerical |
| Volume | 25.0 L | numerical |
| Temperature | 25.0°C | numerical |

1. Before the gas tank was opened, the tank plus the monatomic gas had a mass of 1,053 grams grams. After the tank was opened, the new mass of the tank and its contents is 1,000. grams. Use this information plus your answers to part d. to identify the “X” gas in the tank.

Short answer/no work