CHEMISTRY 101
Hour Exam I
September 22, 2020
Leveritt/McCarren

Name _____KEY_____

Signature _____

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 = 6.022×10^{23}

1 L = 1000 mL

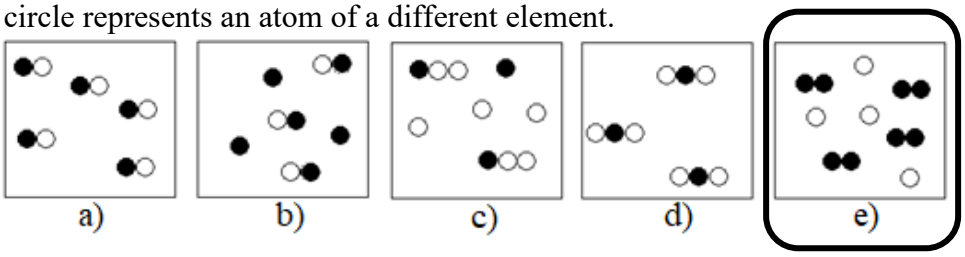
1 atm = 760. torr

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

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

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.



2. How many of the following balloons consist of at least one substance that can be considered a molecule?
   - **A balloon containing sulfur hexafluoride (SF_6)**
   - **A balloon containing a mixture of hydrogen and oxygen gases (H_2 and O_2)**
   - A balloon containing pure helium (He)
   - **A balloon containing pure hydrogen gas (H_2)**

   a) 0 (None of these contain substances which can be considered molecules.)
   b) 1
   c) 2
   d) 3
   e) 4 (All of these contain substances which can be considered molecules.)

3. 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

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

Formula	**Name**
MgS	Magnesium sulfate
Na_3N	Sodium nitrate
Ca_3P_2	**Calcium phosphide**
SO_3	Disulfur trioxide
$BaCO_3$	Barium carbonite

a) 1
b) 2
c) 3
d) 4
e) 5 (All compounds are named correctly.)

5. 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)

a. 0.100 jelly beans
b. 500 jelly beans
c. 1,000 jelly-beans
d. 5,000 jelly-beans
e. 10,000 jelly-beans

6. How many moles of aluminum (Al) are present in a 5.0 gram sample of aluminum foil?
a) 0.0927 moles
b) 0.185 moles
c) 26.98 moles
d) 134.9 moles
e) 269.8 moles

7. 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.
    a) 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.
    b) 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.
    c) 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.
    d) 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.
    e) Both samples contain an equal number of atoms.

8. 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.
    a) Yes: One mole represents 6.022×10^{23} "things" so one mole of both contain 6.022×10^{23} atoms.
    b) 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.
    c) 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.
    d) No: The molar mass of nitrogen gas is greater than the molar mass of neon gas, so the nitrogen sample contains more atoms.
    e) Maybe: The gas samples only have the same number of atoms if both samples have the same volume.

9. What is the percent mass of chlorine in one mole of iron(III) chloride?
    a) 17.5%
    b) 34.4%
    c) 38.8%
    d) 55.9%
    e) 65.6%

10. 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?
    a) SO_3
    b) S_8O
    c) SO_2
    d) SO
    e) S_4O

11. 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?
    - **<u>CH</u>**
    - CH_2
    - **<u>C_2H_2</u>**
    - C_2H_4
    - **<u>C_4H_4</u>**

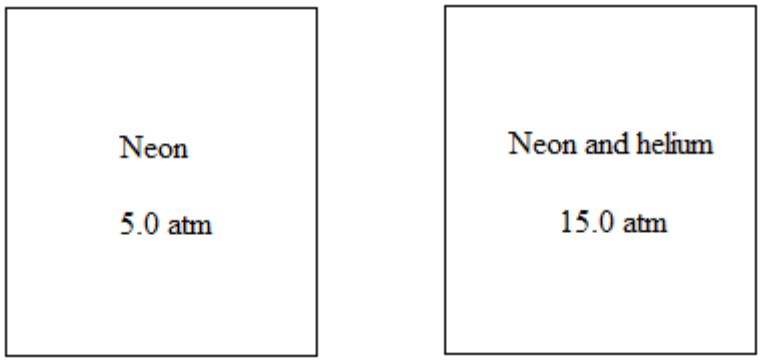
    a) 1
    b) 2
    c) <u>3</u>
    d) 4
    e) 5

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)
    a) <u>Increases:</u> The mass of the gas particles increases as the pressure increases.
    b) <u>Increases: The same mass of gas particles is moving around in a smaller space.</u>
    c) <u>Remains constant:</u> No gas has entered or left the container, so the density remains unchanged.
    d) <u>Decreases:</u> Increasing the pressure causes some gas to leave the container, decreasing the mass of gas present.
    e) <u>Decreases:</u> The gas particles move more slowly after the bottle is squeezed, decreasing the density.

13. 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.
    a. -273 ºC
    b. 25.0 ºC
    c. 31.7 ºC
    d. <u>184 ºC</u>
    e. 457ºC

14. 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 at a constant pressure. What is the new volume of the gas mixture? Assume addition of the neon gas does not change the temperature.
    a. 5.26 liters
    b. 6.67 liters
    c. 25.0 liters
    d. 93.8 liters
    e. <u>119 liters</u>

15. 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 **<u>false</u>** about the neon and helium gases within the container?
    a. There are more helium atoms present in the container than neon atoms.
    b. Each neon atom within the gas mixture contains more protons than each helium atom within the gas mixture.
    c. Both the helium and the neon atoms have the same average kinetic energy.
    d. <u>The mass of helium atoms present is greater than the mass of neon atoms present.</u>
    e. The pressure of neon in the container after the helium gas was added is still 5.0 atm.

Part 2: Free Reponse

Part 1

16. Consider the compound dinitrogen tetroxide. Select all compounds below that have the same empirical formula as this compound.

+1 computer graded

- **N_3O_6**
- N_2O_6
- N_2O_5
- N_2O
- **NO_2**

17. Explain how you know.

+2

The compounds have the same empirical formula because they all can reduce to the same formula (NO_2) when simplified to the lowest whole number atom ratio.

18. Do two compounds with different molecular formulas but with the same empirical formulas have the same percent composition (percent of each element) by mass?

+1 computer graded

Yes/No

19. Give an example to support your answer to the question above. Then, explain in words how your example supports your answer.

+1 example

Yes – compounds with the same empirical formulas still have the same mass percent of each element. For example, the formula NO2 is 30.4% nitrogen by mass. The compound N_2O_4 is also 30.4% nitrogen by mass.

+1 explanation of example

Simply doubling the formula does not change the percent composition because all of the compounds are still present in the same ratio.

Part 2

20. Unknown elements X and Z come from the same family (vertical column) and form ionic compounds X_2O and Z_2O when bonding with oxygen. Which family do elements X and Z come from?

+1 computer graded

a. Alkali metals
b. Alkaline earth metals
c. Halogens
d. Noble gases
e. Metalloids

21. Choose an answer and explain:

+1

Oxygen has a -2 charge in an ionic compound. Therefore, for the compound to have a neutral charge, each ion of X and Z must have a +1 charge to balance the compound overall.

+1

22. X_2O has a greater percent by mass of oxygen than element Z_2O. Which element (X or Z) has a greater molar mass?

+1 computer graded

- X has a greater molar mass.
- **Z has a greater molar mass.**

23. Give an example to support your answer to the question above. Then, explain in words how your example supports your answer.

+1 example

The element with the higher molar mass overall will contribute more to the overall molar mass and mass percent, therefore lessening the mass percent of oxygen. For example, if Z is potassium, making the formula K_2O,

+1 explanation of example

then the compound is 17.0% O by mass. If X is then sodium, with the formula Na_2O, then the compound is 25.8% O by mass. Because oxygen contributes more to the overall molar mass of sodium oxide, that compound has a greater mass percent oxygen and a lower molar mass for the "other" element.

24. Consider a closed, rigid 25.0-liter tank consisting of 5.11 moles of unknown monatomic gas X at 25.0ºC. What is the pressure of the gas in the tank?

+1 computer graded

5.0 atm

25. 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.

+3 computer graded

	Increase, decrease, or constant?
Moles of gas in tank	decrease
Volume of gas in tank	**Constant**
Pressure of gas in tank	**Decrease**
Temperature of gas in tank	**Constant**

26.-28. 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.

+2

+1

+1

+2

Volume	**The volume is constant because the gas still fills the whole container and the size of the tank itself does not change.**
Pressure	**The pressure decreases because there are fewer moles of gas in the container. This is because fewer moles result in fewer collisions of gas particles with the container walls, lowering the pressure.**
Temperature	**The temperature remains constant because the gas is not being heated or cooled.**

30.-31. 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.

+3 computer graded

(1 each)

	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.)	**4.38 atm**
Volume	25.0 L	**25.0 L**
Temperature	25.0°C	**25.0°C**

32. 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.

+1 **Mass of gas: 1,053 g – 1,000 g = 53.g gas lost**

+1 **Moles of gas: 5.11 moles – 4.48 moles = 0.63 moles of gas lost**

+1 **53 g gas / 0.63 moles gas = 84.13 g/mol = Krypton**