

Multiple Choice (50%)

- 1) A sample of argon gas is sealed in a container. The volume of the container is doubled at a constant temperature. What happens to the pressure inside the container?
- A) It cannot be predicted. B) It is squared.
C) It is doubled. D) It is halved.
E) It does not change.
- 2) A sealed rigid container is filled with three ideal gases: NO, CO₂ and N₂. The masses of the gases are known, along with the temperature of the system. What additional information is needed to determine the pressures of the gases in the container?
- A) The average distance traveled between molecular collisions
B) The intermolecular forces
C) The volume of the gas molecules
D) The atmospheric pressure
E) The volume of the tank
- 3) Two balloons are at the same temperature and pressure. One contains only 11.00 g of carbon dioxide and the other contains only 0.505 g of hydrogen. Which one is a true statement?
- A) The density of the carbon dioxide is the same as the density of the hydrogen.
B) The average speed of the carbon dioxide molecules is the same as the average speed of the hydrogen molecules.
C) The average kinetic energy of the carbon dioxide molecules is the same as the average kinetic energy of the hydrogen molecules.
D) The volume of the carbon dioxide balloon is greater than the hydrogen balloon.
E) The number of molecules in the carbon dioxide balloon is the greater than the number of molecules in the hydrogen balloon.
- 4) A reaction produces a gaseous mixture of CO₂, CO and H₂O (g). The mixture is analyzed and found to contain 0.45 mol CO₂, 0.30 mol CO and 1.25 mol H₂O (g). If the total pressure of the mixture was 1.15 atm, what was the partial pressure of the CO?
- A) 0.17 atm B) 0.35 atm
C) 0.19 atm D) 0.30 atm
E) 0.12 atm
- 5) Please determine the formula for a gaseous silane (Si_nH_{2n+2}) if it has a density of 4.12 g/L at STP.
- A) SiH₄ B) Si₂H₆
C) Si₃H₈ C) Si₄H₁₀
E) Si₅H₁₂

6) Choose the gas that probably deviates the most from ideal gas behavior.

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|------------------|------------------|
| A) He | B) NH_3 |
| C) Cl_2 | D) O_2 |
| E) Ar | |

7) A glass flask is filled at room temperature with an equal number of moles of CH_4 , OF_2 and He gases. The gases slowly leak out through a pinhole leak in the cork of the flask. After some of the gas has effused, which one is true of the partial pressures of the gases remaining in the flask?

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| A) $\text{CH}_4 < \text{OF}_2 < \text{He}$ | B) $\text{He} < \text{CH}_4 < \text{OF}_2$ |
| C) $\text{CH}_4 = \text{OF}_2 = \text{He}$ | D) $\text{He} < \text{OF}_2 < \text{CH}_4$ |
| E) $\text{OF}_2 < \text{CH}_4 < \text{He}$ | |

8) Which of the following best explains why a hot air balloon rises?

- A) The heat decreases the volume of the balloon; thus increasing its density.
- B) The heat decreases the volume of the balloon; thus decreasing its density.
- C) The heat increases the volume of the balloon; thus increasing its density.
- D) The heat increases the volume of the balloon; thus decreasing its density.

9) Which of the following conditions would be most likely to cause a gas to behave ideally?

- I. High external pressure
- II. High temperature
- III. Large volume
- IV. Polar covalent molecules
- V. Small intermolecular attractions

- | | |
|----------------------|----------------|
| A) I, II, III, IV, V | B) II, III, IV |
| C) I, II, IV | D) II, IV, V |
| E) II, III, V | |

10) N_2 gas was collected over water at 25°C . If the vapor pressure of water at 28°C is 26 mm Hg and the atmospheric pressure is 755 mm Hg, what is the partial pressure of the N_2 gas?

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|--------------|--------------|
| A) 26 mm Hg | B) 744 mm Hg |
| C) 729 mm Hg | D) 781 mm Hg |
| E) 755 mm Hg | |

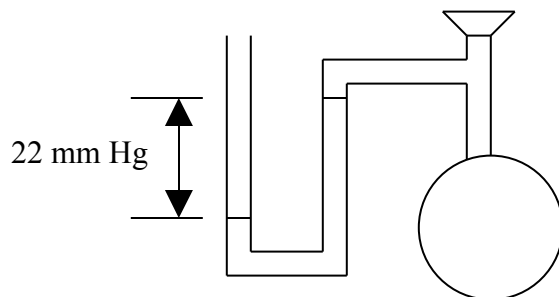
11) A rigid, 5-L metal tank contains He. A sample of Ar is added to the tank. Which one will occur inside the tank?

- I. The temperature of the gas will increase.
- II. The pressure of the gas will increase.
- III. The density of the gas will increase.

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|---------------|-----------|
| A) I | B) II |
| C) I, II | D) I, III |
| E) I, II, III | |

- 12) A sealed container contains 0.10 mol O_2 gas and 0.9 mol H_2 gas. If the temperature is 25°C in the container, which one is true?
- A) The partial pressures of the two gases are the same.
 - B) The average molecular velocities of the two gases are the same.
 - C) The molecular masses of the two gases are the same.
 - D) The masses of the two gases are the same.
 - E) The average kinetic energy of the two gases are the same.

- 13) What is the pressure in this stoppered flask if the atmospheric pressure is 782 mm Hg?



- A) 22 mm Hg
 - B) 804 mm Hg
 - C) 751 mm Hg
 - D) 760 mm Hg
- 14) Please consider 1 mol H_2 and 1 mol N_2 at STP. Which one is not equal for the two samples?
- A) Average molecular velocity
 - B) Average molecular kinetic energy
 - C) Volume
 - D) Number of molecules
- 15) Which one is true?
- A) As the temperature of water increases, its vapor pressure decreases because more liquid evaporates to produce vapor.
 - B) As the temperature of water increases, its vapor pressure increases because more liquid evaporates to produce vapor.
 - C) As the temperature of water increases, its vapor pressure increases because less liquid evaporates to produce vapor.
 - D) As the temperature of water increases, its vapor pressure decreases because less liquid evaporates to produce vapor.
- 16) Which one is false?
- A) Some gases exist at 0°C .
 - B) Some solids exist at 0°C .
 - C) Some liquids exist at 0°C .
 - D) Solids exist at 0 K.
 - E) Some gases exist at 0 K.
- 18) Which one causes the bends as you ascend from a deep dive?
- A) Decreased external pressure causes decreased solubility of gas in your blood.
 - B) Increased external pressure causes increased solubility of gas in your blood.
 - C) Decreased external pressure causes increased solubility of gas in your blood.
 - D) Increased external pressure causes decreased solubility of gas in your blood.

- 19) If you flew to a planet with a normal atmospheric pressure of 0.60 atm, which one would be the least likely?
- A) Hot chocolate is not as hot as on Earth.
 - B) Sprite bottled on Earth fizzes less when it is opened.
 - C) Your ear drums painfully explode.
 - D) A bag of potato chips packaged on Earth appears to have a larger volume.
- 20) If you pack a sealed bottle of suntan lotion in your suitcase in Houston (sea level) & then fly to Colorado for a fun-filled ski trip, which one are you likely to observe when you arrive at the ski resort?
- A) The bottle will bulge inward & lotion will squirt out when you open it.
 - B) The bottle will bulge inward & air will rush in when you open it.
 - C) The bottle will bulge outward & lotion will squirt out when you open it.
 - D) The bottle will bulge outward & air will rush in when you open it.
- 21) Which one would be most likely for H_2O (l)?
- A) It can reach 115°C at 1.5 atm.
 - B) It can reach 115°C at 0.8 atm.
 - C) It can reach 115°C at 1 atm.
 - D) It can reach 100°C at 0.8 atm.
 - E) It can only reach 95°C at 1.5 atm.
- 22) Why do many recipes give high altitude directions?
- A) The high altitude creates a cooler cooking environment.
 - B) Water has a lower boiling point at high altitudes, altering cooking conditions.
 - C) Water has a higher boiling point at high altitudes, altering cooking conditions.
 - D) The high altitude creates a lower pressure environment, altering cooking times.
 - E) The high altitude creates a higher pressure environment, altering cooking times.
- 23) A beaker of water at room temperature (22°C) is placed into a small, closed environment where the atmospheric pressure is 0 atm. Which one will occur?
- A) The water will boil until the vapor pressure prevents the liquid from boiling further.
 - B) The water will boil until all the water has vaporized & the beaker is empty.
 - C) The water molecules will not have enough kinetic energy to vaporize.
 - D) The water will begin to boil when the vapor pressure increases.
 - E) The water will only boil when heat is added to it.

Please use these choices to answer questions 24-25.

- A) The Lake Nyos tragedy
 - B) Tires expand on a hot, August day in Texas.
 - C) Bubbles of gas exhaled by a diver at the bottom of the ocean expand as they rise to the surface of the ocean.
 - D) The pressure inside your lungs is the sum of the partial pressures of nitrogen, oxygen & carbon dioxide gases.
 - E) Perfume diffuses through the air.
 - H) The pressure inside a light bulb increases as it gets hot
- 24) Which one is an example of Boyle's Law?
- 25) Which one is an example of Gay-Lussac's Law?

Problems (60%) **Please show all your work for any credit.**

- 1) A 28.222-g sample of impure $\text{Mn}_2(\text{CO}_3)_5$ is heated to decompose the $\text{Mn}_2(\text{CO}_3)_5$. 10.25 ml CO_2 is collected over water at a temperature of 30.00°C . The gas is collected at an atmospheric pressure of 755 torr. Water has a vapor pressure of 55 torr at 30.00°C . What is the % $\text{Mn}_2(\text{CO}_3)_3$ in the original impure sample?



- 2) $2 \text{C}_2\text{H}_6 (\text{g}) + 2 \text{NH}_3 (\text{g}) + 3 \text{O}_2 (\text{g}) \rightarrow 2 \text{C}_3\text{H}_3\text{N} (\text{g}) + 6 \text{H}_2\text{O} (\text{l})$

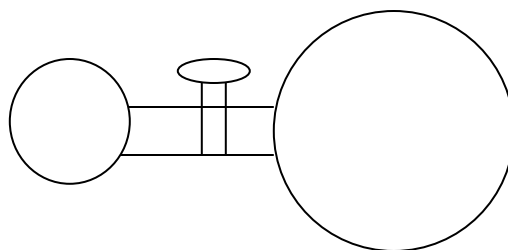
During an experiment, a chemistry student observes that this reaction produces dry $\text{C}_3\text{H}_3\text{N}$ collected in a 600.00-ml flask at 50.00°C at an atmospheric pressure of 0.952 atm. What mass of oxygen was consumed?

- 3) What is the molar mass of this gas?

Mass of Erlenmeyer Flask	153.255 g
Mass of Erlenmeyer Flask + Gas	153.578 g
Mass of Gas	
Volume of Erlenmeyer Flask	162.5 ml
Temperature of Gas in Flask	194°C
Barometric Pressure	751 torr

- 4) A sample of gas in a steel cylinder has a pressure of 10.0 atm at a temperature of -40.00°C . What pressure will the tank have if the temperature is raised to 10.00°C ?

- 5) What is the total pressure in this flask after the stopcock is opened & the gases are allowed to mix at a constant temperature?



1.50 L N₂
2.10 atm

2.80 L O₂
1.50 atm

- 6) A gas has an empirical formula of CH₃. The gas has a density of 2.407 g/L at 125.0°C & 795 torr. What is the molecular formula?
- 7) A 11.0-L sample of air is collected at an atmospheric pressure of 0.621 atm & a temperature of -30.00°C. What volume will the sample have at STP?
- 8) Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This causes sodium azide to decompose explosively according to the following reaction:



What volume will the air bag be if 147 g NaN₃ (s) is detonated when in the air temperature inside the car is 23.0°C with an atmospheric pressure of 773 mm Hg?

- 9) A Ziploc bag has a volume of 2645 ml. The atmospheric pressure is 768 mm Hg & the air temperature is 22.5°C. What mass of CaCO₃ and volume of 0.423 M HCl are necessary in the bag to completely fill it with CO₂? Ignore the HCl volume and the negligible H₂O volume.



- 10) A) In experiment #1, a 0.1647-g sample of a pure hydrocarbon containing only C and H was burned in a combustion chamber to produce 0.4931 g of CO₂ & 0.2691 g H₂O. Assume complete combustion.
- B) In experiment #2, a different 2.200-g sample of the gaseous hydrocarbon is analyzed. It occupies 185.44 ml at 215°C and 1.54 atm.

What is the molecular formula of this gaseous hydrocarbon?

Multiple Choice (50%)

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| 1) _____ | 14) _____ |
| 2) _____ | 15) _____ |
| 3) _____ | 16) _____ |
| 4) _____ | 17) _____ |
| 5) _____ | 18) _____ |
| 6) _____ | 19) _____ |
| 7) _____ | 20) _____ |
| 8) _____ | 21) _____ |
| 9) _____ | 22) _____ |
| 10) _____ | 23) _____ |
| 11) _____ | 24) _____ |
| 12) _____ | 25) _____ |
| 13) _____ | |

Problems (60%)**Please show all your work for any credit.**

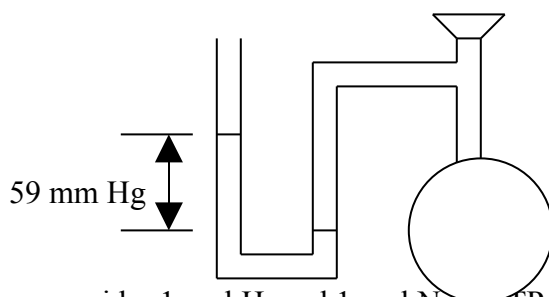
- 1) Please use only the front side of each piece of paper.
- 2) Please number your problems clearly and consecutively.
- 3) Please staple your problems to the back of this page in numerical order.
- 4) Please write on the paper in the conventional manner.
- 5) Please do not make a separate list of answers. Record your answer at the end of the work supporting your answer.
- 6) Please circle/box your answer.

Multiple Choice (50%)

- 1) A sample of argon gas is sealed in a rigid container. The pressure inside the tank is doubled. What has happened to the temperature?
- 2) A sealed rigid container is filled with a sample of gas at a temperature of 300 K and a pressure of 3.45 atm. What additional information would you need in order to calculate the molar mass of this gas?
- 3) Two balloons are at the same temperature and pressure and filled with equal moles of two different gases. Please compare and contrast the KE and velocities of the particles in each balloon.
- 4) A reaction produces a gaseous mixture of CO₂, CO and H₂O (g). The mixture is analyzed and found to contain 0.65 mol CO₂, 0.30 mol CO and 1.25 mol H₂O (g). If the total pressure of the mixture was 3.02 atm, what was the partial pressure of the CO₂?
- 5) Please determine the formula for a gaseous silane (Si_nH_{2n+2}) if it has a density of 6.79 g/L at STP.
- 6) Choose the gas that probably deviates the most from ideal gas behavior.

O₂ NF₃ Cl₂
- 7) A glass flask is filled at room temperature with an equal number of moles of CH₄, N₂ and H₂ gases. The gases slowly leak out through a pinhole leak in the cork of the flask. Please rank the partial pressures in the flask from lowest to highest.
- 8) Why does a hot air balloon rise?
- 9) Please describe the type of molecules that make the most ideal gases. Support your answer.
- 10) N₂ gas was collected over water at 28°C. If the vapor pressure of water at 28°C is 24 mm Hg and the atmospheric pressure is 769 mm Hg, what is the partial pressure of the N₂ gas?
- 11) A rigid, 5-L metal tank contains He. What has happened to the pressure, temperature and density of the gas in the tank after you fill a couple of balloons with He from the tank?

- 12) A sealed container contains 0.2 mol O_2 gas and 0.2 mol H_2 gas. The temperature in the container is constant. Please compare/contrast the KE and velocities of the two gas samples.
- 13) What is the pressure in this stoppered flask if the atmospheric pressure is 763 mm Hg?



- 14) Please consider 1 mol H_2 and 1 mol N_2 at STP. Please list two variables that are equal for these samples.
- 15) How is the vapor pressure of water affected by increasing temperature? Why?
- 16) Please compare/contrast 0°C and 0 K.
- 16) Please describe liquids at 0°C and 0 K.
- 18) What causes the bends as you ascend from a deep dive? Why?
- 19) You fly to a planet with a normal atmospheric pressure of 1.75 atm. What observations would you make about your snack of an unopened bag of potato chips and a bottle of soda?
- 20) If you pack a sealed bottle of suntan lotion in your suitcase in Houston (sea level) & then fly to Colorado for a fun-filled ski trip, which one are you likely to observe when you arrive at the ski resort? Why?
- 21) What effect does pressure have on the boiling point of a liquid? Why?
- 22) Why do many recipes give high altitude directions?

- 23) A beaker of water at room temperature (22°C) is placed into a small, closed environment where the atmospheric pressure is 0 atm. What will you observe as time passes? Why?

Please use these choices to answer questions 24-25.

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 - B) Tires expand on a hot, August day in Texas.
 - C) Bubbles of gas exhaled by a diver at the bottom of the ocean expand as they rise to the surface of the ocean.
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 - E) Perfume diffuses through the air.
 - H) The pressure inside a light bulb increases as it gets hot
- 24) Which one is an example of Charles's Law?
- 25) Which one is an example of Graham's Law?