Name _____**Chem 161, Section**: _____**Group Number:** _____

ALE 24. Ideal Gases, Real Gases and the Kinetic Molecular Theory

(Reference: Chapter 5 - *Silberberg 5th edition*)

Important!! For answers that involve a calculation you must show your work neatly using dimensional analysis with correct significant figures and units to receive full credit. No work, no credit. Report numerical answers to the correct number of significant figures. **CIRCLE ALL NUMERICAL RESPONSES**.

Section 5.5 The Ideal Gas Law and Reaction Stoichiometry

1. How many grams of potassium chlorate decompose to potassium chloride and 638 mL of O_2 at 128 ^oC and 752 torr?

$$2\ KClO_{3(s)} + \text{heat} \rightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$$

2. When 35.6 L of ammonia and 40.5 L of oxygen gas at STP burn, nitrogen monoxide and water are produced. After the products return to STP, how many grams of nitrogen monoxide are present? *Don't forget to balance the equation below*!

$$NH_{3(g)} + O_{2(g)} \rightarrow NO_{(g)} + H_2O_{(l)} \quad \text{(unbalanced!)}$$

3. How many liters of hydrogen gas are collected over water at 18.0 ^oC and 725 mmHg when 0.84 g lithium metal reacts with water to produce aqueous lithium hydroxide and hydrogen gas?

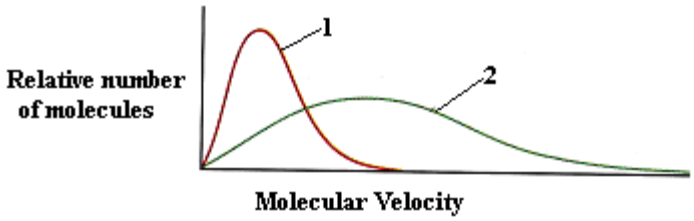
Balanced Chemical Equation: _____

Section 5.6 The Kinetic-Molecular Theory: A Model for Gas Behavior

4. Use the kinetic molecular theory to explain the change in gas pressure that results from warming a sample of gas.

5. How does the kinetic molecular theory explain why 1 mol of krypton and 1 mol of helium have the same volume at STP?

6. The graph below shows the distribution of molecular velocities of a gas at two different temperatures.



a.) Does *curve 1* or *Curve 2* better represent the behavior of the gas at the lower temperature? *Explain your reasoning*.

b.) Which curve represents the sample with the higher average kinetic energy, $E_{k(ave.)}$? *Explain your reasoning*.

c.) Which curve represents the sample that diffuses more quickly? *Explain your reasoning*.

d.) Suppose that curves 1 and 2 represent two different gases at the *same* temperature. If the gases are helium and neon, match the curves with each gas. *Explain your reasoning*.
Hints: i.) Substances at the same temperature have the same average kinetic energy; ii.) Kinetic Energy of a particle is related to the mass of the particle (m) and its velocity (v): $\mathbf{E_k = ½\ mv^2}$

Section 5.7 Real Gases: Deviations from Ideal Behavior

7. a.) Explain why large gaseous molecules deviate from ideal behavior. That is, explain why gaseous molecules of high molecular size have positive deviations from the PV/RT ratio of an ideal gas: which variable in this ratio is affected? How is it affected? Why is it affected?

b.) Use the data from Table 5.5 on page 223 to rank $\mathbf{Cl_2}$, $\mathbf{H_2}$ and $\mathbf{O_2}$ in order of increasing magnitude of these deviations.

increasing deviation from ideal behavior →

_____ < _____ < _____

Explain your reasoning:

8. Does sulfur hexafluoride, SF_6, (boiling point 16 °C at 1 atm) behave more ideally at 150 °C or 20 °C? *Explain your reasoning*.

Comprehensive Problems

9. Will the volume of a gas increase, decrease, or remain unchanged for each of the following sets of changes. *Justify your response in **each** case*.
   a.) The pressure is decreased from 2 atm to 1 atm, while the temperature is decreased from 200 ^{o}C to 100 ^{o}C.

   b.) The pressure is increased from 1 atm to 3 atm, while the temperature is increased from 100 ^{o}C to 300 ^{o}C.

   c.) The pressure is increased from 3 atm to 6 atm, while the temperature is increased from -73 ^{o}C to 127 ^{o}C.

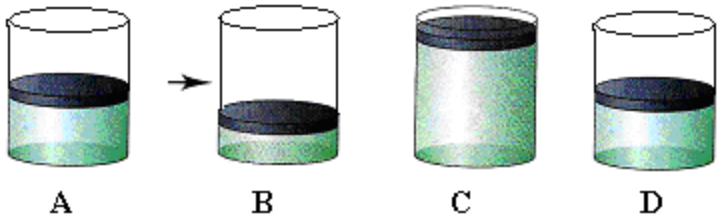
10. Automobile air bags respond to a collision of a preset strength by electrically triggering the explosive decomposition of sodium azide (NaN_3) to its elements, sodium metal and nitrogen gas. In an industrial lab simulation, 15.3 mL of nitrogen gas was collected *over water* at 25.0 ^{o}C and 755 torr. How many grams of sodium azide decomposed?

    Balanced Chemical Equation: _____

11. Ammonium nitrate, a common fertilizer, is used as an explosive in fireworks and by terrorists. It was the material used in the devastating and tragic explosion of the Oklahoma City federal building in 1995. How many liters of gas at 307 ^{o}C and 1 atm are formed by the explosive decomposition of 15.0 kg of ammonium nitrate to nitrogen gas, oxygen gas and water vapor?

Balanced Chemical Equation: _____

12. Cylinder A, below, contains 0.1 mol of an ideal gas. Choose the cylinder (B, C, or D) that correctly represents the volume of the gas after each of the following changes. If none of the cylinders is correct, state "none."



a.) *P* is doubled at fixed *n* and *T* . **Cylinder:** _____

b.) *T* is reduced from 400 K to 200 K at fixed *n* and *P*. **Cylinder:** _____

c.) *T* is increased from 100^{o}C to 200^{o}C at fixed *n* and *P*. **Cylinder:** _____

d.) 0.1 mol of gas is added at fixed *P* and *T*. **Cylinder:** _____

e.) 0.1 mol of gas is added and *P* is doubled at fixed *T*. **Cylinder:** _____