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Workshop #7: Gas Laws

Show calculation setups and answers for all problems below.

1. A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.5 L. The balloon is filled with 2.0 L of helium at sea level (pressure = 1.00 atm), is released, and rises to an altitude at which the atmospheric pressure is only 500.0 mmHg. Assuming that the temperature remains constant, will the balloon burst? Quantify your response and briefly explain.

2. Another balloon is filled with 150 L of helium at 23 °C and 1.0 atm. What volume does the balloon have when it has risen to a point in the atmosphere where the pressure is 220 mmHg and the temperature is –31 °C?

3. Calculate the mass of hydrogen gas needed to fill an 80.0 L tank to a pressure of 2205 psi at 27 °C.

4. What volume does 35 mol of nitrogen gas occupy at STP?

5. The mass of a 3.21 L gas is found to be 3.50 g, measured at 65.0 ºC and 500.0 torr. Determine the molar mass of the gas.

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6. Calculate the density of water vapor at 110 °C and 99 kPa.

7. A compound with the empirical formula BH_3 was found to have a vapor density of 1.24 g / L at STP. Determine the molecular weight AND the molecular formula of this gas.

8. Consider the reaction of solid copper(I) sulfide with oxygen gas to produce solid copper(I) oxide and gaseous sulfur dioxide.

   A. Write the balanced chemical equation for this process.

   B. What volume of oxygen gas, measured at 27.5 °C and 0.998 atm, is required to react with 25 g of copper(I) sulfide?

9. A sample of solid potassium chlorate is decomposed, forming solid potassium chloride and gaseous oxygen. The oxygen produced was collected by displacement of water at 22 °C at a total pressure of 754 torr. The volume of the gas collected was 0.65 L, and the vapor pressure of water at 22 °C is 21 torr.

   A. Write the balanced chemical equation for this process.

   B. Determine the mass of potassium chlorate in the sample that was decomposed.

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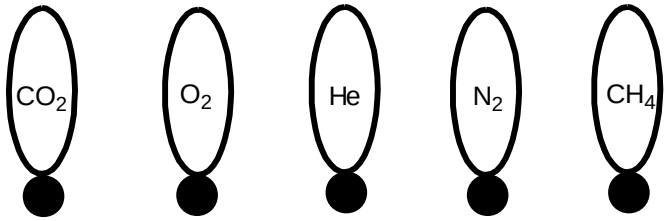
10. Represented below are five identical balloons, each filled to the same volume at 25 °C and 1.0 atm pressure with the pure gases indicated.



A. Which balloon contains the greatest mass of gas? Explain.

B. Compare the average kinetic energies of the gas molecules in the balloons. Explain.

C. Which balloon contains the gas that would be expected to deviate most from the behavior of an ideal gas? Explain.

D. Twelve hours after being filled, all the balloons have decreased in size. Predict which balloon will be the smallest. Explain your reasoning.

11. Calculate the root-mean-square speed (u_{rms}) for:

A. a xenon atom at 298 K;

B. an oxygen molecule at 298 K.

12. Both hydrogen and helium have been used as buoyant gases in blimps. If a small leak were to occur in a blimp filled with both gases, which gas would effuse more rapidly and by what factor?

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13. A gas of unknown molecular mass was allowed to effuse through a small opening under constant pressure conditions. It required 72 s for the gas to effuse. Under identical experimental conditions, it required 28 s for O_2 gas to effuse. Determine the molar mass of the unknown gas.

14. Calculate the pressure exerted by 50.0 g CO(g) in a 1.00 L container at 25 °C by:

    Useful information: For CO, a = 1.49 atm L^2/mol^2 and b = 0.0399 L/mol

    A. using the ideal gas law, and

    B. using the van der Waals equation.

15. Compare the results from parts A and B. Does CO(g) behave ideally under these conditions? Briefly explain why or why not.