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Gases: Physical Properties, Behavior, and Stoichiometry

1. How does a sample of gas differ in its behavior from a sample of liquid in each of the following situations?
2. The sample is transferred from one container to another.
3. The sample is heated in an expandable container but no change of state occurs.
4. The sample is placed in a cylinder with a piston and an external force is applied.
5. How does a barometer work? Is the column of mercury shorter at a mountaintop or at sea level? Explain.
6. Convert each of the pressures described below to atm.
   1. At the peak of Mt. Everest, atmospheric pressure is only 2.75 x 102 mmHg.
   2. A cyclist fills her bicycle tire to 86 psi.
   3. The surface of Venus has an atmospheric pressure of 9.15 x 106 Pa.
   4. At 100 ft below sea level, a scuba diver experiences a pressure of 2.54x104torr.
7. A gas-filled weather balloon with a volume of 65.0 L is released at sea-level conditions of 745 torr and 25oC. The balloon can expand to a maximum volume of 835L. When the balloon rises to an altitude at which the temperature is -5oC and the pressure is 0.066 atm, will it reach its maximum volume?
8. Why is moist air less dense than dry air?
9. A baker uses sodium hydrogen carbonate as the leavening agent in banana-nut bread. The baking soda decomposes according to two possible reactions.
   1. 2NaHCO3(s) 🡪 Na2CO3(s) + H2O (l) + CO2(g)
   2. NaHCO3(s) + H+(aq)🡪 H2O (l) + CO2(g) + Na+(aq)

Calculate the volume (mL) of CO2 that forms at 200oC and 0.975 atm per gram of NaHCO3 by each of the reaction processes.

1. Will the volume of a gas increase, decrease, or remain the same for each of the following changes? Explain each
   1. The pressure decreased from 2 atm to 1 atm, while the temperature is decreased from 200oC to 100oC.
   2. The pressure is increased from 1 atm to 3 atm, while the temperature is increased from 100oC to 300oC.
   3. The pressure is increased from 0.2 atm to 0.4 atm, while the temperature is decreased from 300oC to 150oC.
2. Explain why gases at low temperature and high pressure do not obey the ideal gas equation as well as gases at high temperature and low pressure.
3. The air that enters an automobile engine contains the oxygen that reacts with the hydrocarbon fuel vapors to provide the energy needed to move the vehicle. Prior to the combustion process the fuel-air mixture is compressed and then it is ignited with a spark. Most of the fuel is completely burned to CO2 and H2O, and some of the nitrogen in the air is converted to nitrogen monoxide, NO. For simplicity, assume the fuel has a formula of C8H18 and a density of 0.760g/mL.
   1. What are the partial pressures of N2 and O2 in the air before it goes into the engine if the atmospheric pressure is 734 mm Hg? <http://www.universetoday.com/26656/composition-of-the-earths-atmosphere/>
   2. If no fuel was added to the air and it was compressed to seven times atmospheric pressure (approximately the compression ratio in a modern engine), what would the partial pressures of N2 and O2 become?
   3. Assume the volume of each cylinder in the engine is 485 mL and that the temperature is 150oC. If 0.050 mL of the fuel is added to the air in each cylinder just before compression, and the fuel is completely vaporized, what would be the partial pressure of the fuel vapor?
   4. How many moles of O2 would be required to burn the fuel completely to CO2 and H2O?
   5. If 10. % of the nitrogen in the combustion process is converted to NO, calculate how many grams of NO are produced in a single combustion reaction?
   6. Write an equation that shows the conversion of NO to a more photoreactive compound. (research)
   7. Calculate the mass of the more photoreactive compound that would be formed from the NO produced in part e.
   8. What additional information would you need to calculate the NO emissions for an entire city for a year?
4. A chemist weighted out a 5.14 g of a mixture of CaO(s) and BaO(s) and placed the sample in a 1.50 L flask containing CO2(g) at 30.0oC and 750.torr. After the reaction to form BaCO3 and CaCO3 was completed, the pressure of CO2 (g) remaining was 230.torr. Calculate the mass percentages of CaO(s) and BaO(s) in the original mixture.