CHEM 103
R&R 17
25 June 2024
Adapted from a 23 June 2020 document

1. A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.50 L. A balloon enthusiast fills the balloon with 2.00 L helium at sea level; she plans to have the balloon rise to an altitude at which atmospheric pressure is only 500. mm Hg. Will the balloon burst before reaching that altitude?

2. A mixture of NH_3 (g) and N_2H_4 (g) is placed in a sealed container at 300 K. The total pressure is 0.50 atm. The container is heated to 1200 K, at which time both substances decompose completely according to the following unbalanced equations:

$$NH_3\ (g) \rightarrow N_2\ (g) + H_2\ (g)$$
$$N_2H_4\ (g) \rightarrow N_2\ (g) + H_2\ (g)$$

After decomposition is complete, the total pressure at 1200 K is found to be 4.5 atm. Find the mole percent of N_2H_4 (g) in the original mixtures. Assume two significant figures for the temperature.

3. 5.00 g solid calcium carbonate reacts with 100.0 mL of 0.200 M hydrochloric acid, represented by the following unbalanced equation:

$$CaCO_3 + HCl \rightarrow CaCl_2 + H_2O + CO_2$$

What volume of carbon dioxide gas is produced at a pressure of 750.0 mm Hg and a temperature of 22.0 °C?

4. Using the molecular orbital model, describe the bonding, magnetism, and relative bond orders of the following species:

$$O_2,\ O_2^-,\ O_2^{2-}$$

5. A quantity of N_2 gas originally held at 5.25 atm in a 1.00-L container at 26 °C is transferred to a 12.5-L container at 20 °C. A quantity of O_2 gas originally at 5.25 atm and 26 °C in a 5.00-L container is transferred to this same container. What is the total pressure in the new container?

6. A sample of 6.3 mg of a boron hydride is contained in a 385-mL flask at 25.0 °C and a pressure of 11 torr.

a. Determine the molar mass of the boron hydride. (1 atm = 760 torr)

b. Which of the following boron hydrides is contained in the flask: BH_3, B_2H_6, or B_4H_{10}?

7. You may recall a discussion of gypsum, $CaSO_4 \cdot 2\ H_2O$, from R&R Worksheet 2. Back then, we calculated how much mass is lost as water vapor when gypsum is heated. We now have the tools to determine the volume or pressure of that water vapor!

Suppose I place 275 g of gypsum into a vacuum-sealed, highly reinforced 5.00-L container containing 1.00 atm of N_2 gas at 20.0 °C. I heat the gypsum until it is transformed into fully anhydrous calcium sulfate. I then heat my container to 727.0 °C.

The density of gypsum is 2.32 g cm^{-3}. The density of $CaSO_4$ is 2.97 g cm^{-3}.

a. After I place the gypsum into the container, but before I first heat the container, what is the pressure of the N_2 gas in the container?

b. How many moles of H_2O are given off by heating the gypsum?

c. What is the final pressure of gas within my container?