

Determining the Vapor Pressure of a Gas by P-T Extrapolation

OBJECTIVES

It is proposed that experiments be conducted that involve the volume of one mole of hydrogen gas at standard temperature and pressure (STP). Hydrogen will be generated, the volume collected above some of hydrogen will be known, and the hydrogen gas measured will be known. The volume of hydrogen will be known by water displacement and be corrected and converted for differences in temperature and pressure in order to compare the actual volume of hydrogen at STP.

Background Information

Avogadro's Law states that equal volumes of gases contain equal numbers of molecules under the same conditions of temperature and pressure. In laboratory situations, this will give us hydrogen containing the same number of molecules with volume the same volume if the temperature and pressure are kept constant. The volume occupied by one mole of gas is called the molar volume. In this experiment, the molar volume of hydrogen gas at standard temperature and pressure (STP) equal to 22.4 L will be used to compare and contrast.

The volume of hydrogen gas at standard pressure (1 atmosphere) and 0°C provides a convenient means of generating hydrogen gas.

Figure 1. Hydrogen Gas Collection Setup

Equation 1

If the reaction occurred in a well sealed hydrogen gas cell, the volume of hydrogen gas collected will depend on the number of moles of hydrogen as well as the pressure and temperature. The molar volume of hydrogen gas is calculated if the volume occupied by a single molecule is known number of moles of hydrogen is known. Since the volume will be measured under laboratory conditions of temperature and pressure, the measured volume for one mole of STP conditions for one mole of hydrogen gas is known.

The relationship among the four gas variables, pressure (P), volume (V), temperature (T), and the number of moles (n), is expressed in the ideal gas law (Equation 2), where R is a constant called the universal gas constant.

$$PV = nRT$$

Equation 2

If the ideal gas law is known in Equation 2, the number of moles of gas is known. If the universal gas law is known and the volume (V) and a gas at STP (T) and P is known then volume (V) can be calculated under any other gas conditions (T) and P. The relationship that ideal gas law is the number of gas law, assuming that temperature and pressure is constant for constant volume. In the ideal gas law, assuming that temperature and pressure is constant for constant volume. In the ideal gas law, assuming that temperature and pressure is constant for constant volume.

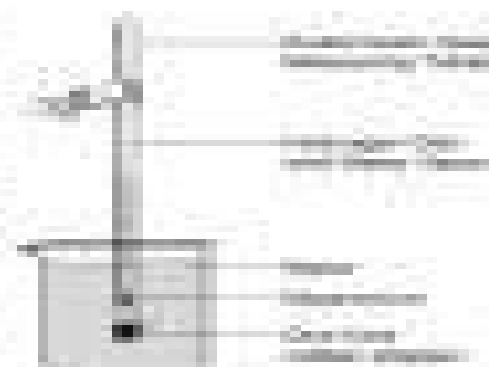
$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Equation 3

Hydrogen gas will be collected by the displacement of water in an inverted gas collecting tube which is submerged in water using the apparatus shown in Figure 1. The total pressure of the gas within will be equal to the atmospheric gas pressure. However, the gas in the cylinder contains the gas hydrogen. The gas within a water-water vapor shows the composition of the atmosphere from which hydrogen is being collected. According to Dalton's Law, the total pressure of the gas will be equal to the partial pressure of hydrogen plus the partial pressure of water vapor (Equation 4). The vapor pressure of water depends only on the temperature (see Table 1).

$$P_{\text{total}} = P_{\text{H}_2} + P_{\text{H}_2\text{O}}$$

Equation 4



Determining Molar Volume Gas Post Lab Answers

Michael Horton



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