Charles law lab report

The volume of the air sample at the high temperature, (Vn), decreases when the sample is cooled to the low temperature and becomesV1. All of these measurements are made directly. The experimental data is then used to verify Charles'law by two methods: 1. The experimental volume (V"" o) measured at the low temperature is compared to the V1 predicted by Charles' law where Yy(t oretic (vH,[he at)= +) 165 2. The V/T ratios for the air sample measured at both the high and the low temperatures are compared. Charles'law predicts that these ratios will be equal. V" _V" TH TL

Pressure Considerations The relationship between temperature and volume defined by Charles' law is valid only if the pressure is the same when the volume is measured at each temperature. That is not the case in this experiment. 1. The volume, Vs, of air at the higher temperature, Ts, is measured at atmospheric pressure' P" t* in a dry Erlenmeyer flask. The air is assumed to be dry and the pres. nr" is obtained from a barometer. 2. The experimental air volume, (V"*p) at the lower temperature, Tp, is measured. over water. This volume is saturated with water vapor that contributes to the total pressure in the flask.

Therefore, the experimental volume must be corrected to the volume of dry anrat atmospheric pressure. This is done using Boyle's law as follows: a. The partial pressure of the dry air, Poo, is calculated by subtracting the vapor pressure of water from atmospheric pressure: P. r–PffrO= POA b. The volume that this dry air would occupy at Pur," is then calculated using the Boyle's law equation: = (%,. oXp*) (voo)(%, _) (%,. oXp*) . = Sffi (voo) PROCEDURE Wear protective glasses. NOTE: It is essential that the Erlenmeyer flask and rubber stopper assemblvbe as drv as possiblein order to obtain reproducibleresults.

Dry a L25 mL Erlenmeyer flask by gently heating the entire outer surface with a burner flame. Care must be used in heating to avoid breaking the flask. If the flask is wet, first wipe the inner and outer surfaces with a towel to remove nearly all the water. Then, holding the flask with a test tube holder, gently heat the entire flask. Avoid placing the flask directly in the flame. Allow to cool. While the flask is cooling select a l-hole rubber stopper to fit the flask and insert a b cm piece of glass tubing into the stopper so that the end of the tubing is flush with the bottom of 66 the stopper. Attach a 3 cm piece of rubbertubingto the glass tubing (see Figure 19. 1-). Insert (wax pencil) the distance that it is inserted. Clamp the the stopper into the flask and mark flask so that it is submerged as far as possible in water contained in a 400 mL beaker (without the flask touching the bottom of the beaker) (see Figure I9. 2). Heat the water to boiling. Keep the flask in the gently boiling water for at least 8 minutes to allow the air in the flask to attain the temperature of the boiling water. Add water as needed to maintain the water level in the beaker.

Read and record the temperature of the boiling water. While the flask is still in the boiling water, seal it by clamping the rubber tubing tightly with a screw clamp. Remove the flask from the hot water and submerge it in a pan of cold water, keeping the top down at all times to avoid losing air. Remove the screw clamp, letting the cold water flow into the flask. Keep the flask totally submerged for about 6 minutes to allow the flask and contents to attain the temperature of the water. Read and record the temperature of the water in the pan. Figure 19. Rubber stopper assembly Figure 19. 2 Heating the flask (and air) in boiling water t67 In order to equalize the pressure inside the flask with that of the atmosphere, bring the water level in the flask to the same level as the water in the pan by raising or lowering the flask (see Figure 19. 3). With the water levels equal, pinch the rubber tubing to close the flask. Remove the flask from the water and set it down on the laboratory bench. Using a graduated cylinder carefully measure and record the volume of liquid in the flask. Repeat the entire experiment.

Use the same flask and flame dry again; make sure that the rubber stopper assembly is thoroughly dried inside and outside. After the second trial fill the flask to the brim with water and insert the stopper assembly to the mark, letting the glass and rubber frll to the top and overflow. Measure the volume of water in the flask. Since this volume is the total volume of the flask, record it as the volume of air at the higher temperature. Because the same flask is used in both trials. it is necessarv to make this measurement onlv once. Figure 19. 3 Equalizing the pressure in the flask.

The water level inside the flask is adjusted to the level of the water in the pan by raising or lowering the flask. 168 NAME SECTION DATE REPORT FOREXPERIMENT 19 Charles’Law INSTRUCTOR Data Table Tlial 1 Temperature of boiling water, Ts Temperature of cold water, Tp Volume of water collected in flask (decreasein volume due to cooling) -oC, OC. K -OC, -OC, T? ial 2 -K -K -K Volume of air at higher temperature, Vs (volume of flask measured onlv after Trial 2) Volume of wet air at lower temperature (volume of flask less volume of water collected), V”” p Atmosphere pressure, P” t(barometer reading)

Vapor pressure of water at lower temperature, Puoo (seeAppendix 6) 169 REPORT FOR EXPERIMENT 19 (continued) NAME CALCULATIONS: In the spaces below, show calculation setups for T? ial 1 only. Show answers for both trials in the boxes Tbial 1 1. Corrected experimental volume of dry air at the lower temperature calculated from data obtained at the lower temperature. (a) Pressure of dry air (Ppa) POL= PAr–Pg” O T)ial2 (b) Corrected experimental volume of dry air (lower temperature). = vnr=(%*’)|. +tl Po,”[J 2 . Predicted volume of dry air at lower temperature