

FUNCTIONS EXPERIMENT PRESSURE AND TEMPERATURE

Introduction

A fundamental law of physics describes how the pressure of a fixed mass of gas at a constant volume is related to its temperature. This law states that the pressure of the gas is proportional to the temperature of the gas in measured in kelvins. This means that pressure P is related to temperature T by the formula

$$P = cT$$

for some constant c . We will refer to this as the *pressure-temperature law*. In this experiment we will test this law by varying the temperature of an air sample in a medicine bottle (by submerging the medicine bottle in water baths of different temperatures) and measuring the resulting pressure changes with a pressure sensor.

Equipment and Setup

For this lab you will need a TI calculator with the Vernier PHYSICS program loaded, a CBL unit, a Vernier pressure sensor, a temperature probe, five or six coffee cups, and a small plastic bottle with a snap on lid such as a medicine bottle or a 35 mm film bottle.

Drill a small hole in the top of the plastic bottle just large enough to push the tubing from the pressure sensor through. Seal the lid and tubing with duck tape. Connect the tubing to the pressure sensor. Plug the temperature probe and the pressure sensor into channels 1 and 2, respectively, on the CBL unit. Fill each of the coffee cups with water of a different temperature, ranging from ice cold to boiling hot. Run the PHYSICS program and follow the instructions on the screen for setting up the probes. You are now ready to begin collecting data.

Procedure

From the DATA COLLECTION menu in the PHYSICS program choose TRIGGER. Place the temperature probe and the plastic bottle in one of the water baths. Monitor the temperature on the CBL unit. When the temperature stops changing and the probe has reached the temperature of the water, press [TRIGGER] on the CBL unit to record the temperature and pressure. Place the plastic bottle in a different water bath and repeat the data collection process. When you are finished collecting data the calculator will show a graph of the pressure versus temperature.

Data

Record the data you collected in the table below. You will need to convert the temperatures collected from degrees Celsius to kelvins by using the formula

$$K = C + 273.15,$$

where C is the temperature in degrees Celsius and K is the temperature in kelvins.

Pressure versus Temperature

Temperature (kelvins)						
Pressure (atm)						

Analysis

1. Find the equation of the regression line model for pressure as a function of temperature. Be sure to identify what the letters you use mean, and round the regression line parameters to four decimal places.

2. Check that your formula makes sense by graphing your formula with the data.

3. Identify the slope of your regression line, and explain what it means in practical terms.

4. According to the pressure-temperature law, what should the vertical intercept in your formula be?

5. Does the data that you collected support the pressure-temperature law? Explain.