The Enthalpy of Vaporization of Ethanol

# Introduction

A pure liquid will have a vapor pressure that is a function of the liquid-vapor equilibrium temperature. The relationship between temperature and vapor pressure is given by the Clausius-Clapeyron equation:

ln P = -ΔHvap/RT + ln A

where ΔHvap is the molar enthalpy of vaporization for the substance measured in J/mole, R is the ideal gas constant 8.314 J/mol-K, and T is the temperature measured in Kelvin. The constant A is ‘everything else’ that has an effect on the vapor pressure of the gas.

In this investigation, ethanol will be shown to follow this equation from plots of vapor pressure as a function of temperature (P vs T) and the logarithm of pressure as a function of inverse temperature (ln P vs 1/T). The enthalpy of vaporization of ethanol may then be determined from the slope of the line on the second graph: ΔHvap = slope\*R.

P

T

ln P

1/T

# Materials and Methods

LabQuest2

150 mL Erlenmeyer flask

Pressure sensor with two-holed stopper and tubing

Temperature sensor

600-mL beaker

Ethanol

# Procedure

1. Attach a pressure sensor to Channel 1 and a temperature probe to Channel 2 of a LabQuest and open the file *PTgas.qmbl*. Obtain a 125 mL flask with a two-holed stopper. Attach a Vernier pressure sensor via the plastic tubing to one side; the other side should have a closable valve.
2. Attach a vacuum hose to the valve in the open position and remove as much of air as possible. The pressure should read around 10 kPa. Closing the valve and removing the vacuum hose and record the pressure on the Report Sheet.
3. Obtain approximately 3 mL of ethanol in a 20-mL syringe and screw it onto the valve. Open the valve to let the ethanol enter the flask, then close the valve again and remove the syringe.
4. Submerge the flask up to its neck in a 600 mL beaker filled with cold water on a hot plate, and place the temperature probe in the water bath, as shown in the figure:



1. Begin data collection by tapping on the green arrow. Record the pressure as a function of temperature as the water bath is heated, ‘keeping’ data about every five Celsius up to a maximum temperature of 75 Celsius.

# Data and Results

1. Stop data collection and record the data from the data table screen into the data table on the Report Sheet. Use either Logger Pro or a calculator to calculate the natural log of the pressure, ln P, and the inverse of the temperature when measured in Kelvin, 1/T.
2. Construct a plot of pressure on the y-axis versus temperature in Celsius on the x-axis using Logger Pro, another graphing program, or by hand on graph paper. This is the plot shown on the graph screen after data collection is complete. Include a hard copy of the graph with the Report Sheet.
3. Construct a second plot of log of pressure on the y-axis versus inverse temperature on the x-axis using Logger Pro, another graphing program, or by hand on graph paper.
4. Find the best straight line through the data and report the slope of the line (with units) on the Report Sheet. Use the relationship

ΔHvap = slope\*R

to calculate the enthalpy of vaporization for ethanol. Report the value in units of kJ/mol.