When a volatile liquid is added to a closed container such as an Erlenmeyer flask as shown in Figure 1, it will evaporate into the air above it in the container. Eventually, equilibrium is reached between the rate of evaporation and the rate of condensation. At this point, the vapor pressure of the liquid is equal to the partial pressure of its vapor in the flask.

In the Preliminary Activity, you will determine the vapor pressure of ethanol at room temperature using a Gas Pressure Sensor and a Temperature Probe. You will first measure air pressure at room temperature. You will then add ethanol to the flask and, once equilibrium has been established, measure the total pressure exerted by air and ethanol vapor. You will then subtract air pressure from the total pressure to determine the vapor pressure of ethanol at that temperature.

After completing the Preliminary Activity, you will first use reference sources to find out more about vapor pressure before you choose and investigate a researchable question dealing with vapor pressure. Some topics to consider in your reference search are:

- evaporation
- vapor pressure equilibrium
- alcohols
- hydrocarbons
- intermolecular attractions
- hydrogen bonding
- dispersion forces
- isomers
- heat of vaporization
- Raoult’s law
- Clausius-Clapeyron equation
Experiment 14

PROCEDURE

1. Obtain and wear goggles. **CAUTION:** The alcohol used in this experiment is flammable and poisonous. Avoid inhaling the vapors. Avoid contact with your skin or clothing. Be sure that there are no open flames in the room during the experiment. Notify your instructor immediately if an accident occurs.

2. Connect a Gas Pressure Sensor to Channel 1 and a Temperature Probe to Channel 2 of the data-collection interface. Start the data-collection program.

3. Attach the rubber-stopper assembly.
   a. Use the clear tubing to connect the white rubber stopper to the Gas Pressure Sensor. (About one-half turn of the fittings will secure the tubing tightly.)
   b. Twist the white stopper snugly into the neck of the Erlenmeyer flask to avoid losing any of the gas that will be produced as ethanol evaporates. (See Figure 1)

4. Finish setting up the apparatus shown in Figure 1.
   a. Make sure that the two-way valve above the rubber stopper is open.
   b. Obtain a room-temperature water bath.
   c. Place the Temperature Probe in the water bath.
   d. Hold the flask in the water bath, with the entire flask covered as shown in Figure 1.
   e. After 30 seconds, close the 2-way valve.

5. Obtain a small amount of ethanol. Draw 3 mL of ethanol into the 20 mL syringe that is part of the Gas Pressure Sensor accessories. With the two-way valve on the white stopper closed, thread the syringe onto it (see Figure 1).

6. Begin data collection. After about 10 seconds have elapsed, and the initial temperature and pressure readings have been taken, add ethanol as described in Step 7.

7. Add ethanol to the flask.
   a. Open the valve below the syringe containing the 3 mL of ethanol.
   b. Push down on the plunger of the syringe to inject the ethanol.
   c. **Quickly** pull the plunger back to the 3 mL mark, and close the valve below the syringe.
   d. Carefully remove the syringe from the stopper so that the stopper is not moved.

8. Monitor the pressure and temperature readings. When the pressure readings stabilize, end data collection.

9. Gently loosen and remove the stopper assembly from the flask and dispose of the ethanol as directed by your instructor.
QUESTIONS

1. Select the initial 10 second region of the *temperature* graph. Use the Statistics function to determine the mean temperature during this period. Record this value to the nearest 0.1°C.

2. Select the initial 10 second region of the *pressure* graph. Use the Statistics function to determine the mean air pressure value during this period—before the addition of ethanol. Record this value.

3. Select the highest flat region of the *pressure* graph beyond the pressure spike caused by the addition of ethanol. Use the Statistics function to determine the mean pressure reading for this region, and record this value. This is the total pressure exerted by the ethanol vapor and air mixture.

4. Determine the vapor pressure of ethanol by subtracting the air pressure value obtained in Question 2 from the total pressure value for the ethanol vapor and air mixture obtained in Question 3.

5. List three factors that could possibly affect the magnitude of vapor pressure.

6. List at least one researchable question concerning vapor pressure.

**Note:** The plan that you submit for instructor approval should list laboratory safety concerns, including chemical safety concerns, and specify how you will address these safety concerns during your investigation.
Vernier Lab Safety Instructions Disclaimer

This copy does not include:

- Safety information
- Essential instructor background information
- Directions for preparing solutions
- Important tips for successfully doing these labs