

Purpose: To observe the relationships that exist among the pressure, volume, and temperature of a sample of gas

Procedure:

- ① Prepare a water bath by filling a 600 mL beaker about $\frac{2}{3}$ of the way full with water. Add a stir bar and heat the water bath on a hot plate with moderate stirring. Hot plates with digital temperature settings should be set to 30.0°C , while those with numerical settings should be at 5-6.
- ② Plug the pressure sensor into Channel 1 of the LabPro interface and the temperature probe into Channel 2.
- ③ You should have a rubber-stopper assembly with a piece of heavy-wall plastic tubing connected to one of its two valves. Attach the connector at the free end of the plastic tubing to the open stem of the pressure sensor with a gentle clockwise turn. Leave the two-way valve on the rubber stopper open (lined up with the valve stem) so that the flask is open to the air.
- ④ Insert the rubber-stopper assembly into a dry 125 mL Erlenmeyer flask. Twist the stopper into the neck of the flask to ensure a tight fit.
- ⑤ Prepare the computer for data collection by opening the appropriate Logger Pro experiment file. The vertical axis should show pressure and the horizontal axis should show temperature.
- ⑥ Leak Test
 - a. Take the 20 mL syringe and adjust the plunger so that the black ring is positioned at 0 mL. Attach the syringe to the two-way valve and open the valve. Remove air from the apparatus by moving the plunger to the 20 mL mark. Close the two-way valve. Watch the pressure reading for 30 seconds. If the pressure increases back to room pressure, then a leak is present.

b. Consult your TA if there is a leak in the system.

⑦ Click to begin data collection.

⑧ Collect pressure vs. temperature data for your gas sample:

a. Place the flask into the water bath and raise the temperature of the bath until it is boiling or near boiling. Use a 3-pronged clamp to hold the Erlenmeyer flask in the water bath so that most of the flask is submerged in the water. Keep all wires and tubing away from the surface of the hot plates.

b. Place the temperature probe into the water bath. Again, keep the wires away from the surface of the hot plate.

c. Close the two-way valve above the rubber stopper by turning the valve handle so it is perpendicular with the valve stem itself. The air sample to be studied is now confined in the flask.

d. When the pressure and temperature readings displayed in the meter window stabilize, click . You have now saved the first pressure-temperature data pair.

⑨ Turn off heat and let the water bath cool slowly.

⑩ Collect a new data point approximately every 5°C as the water cools. Keep cooling the water bath down to 0°C . You will need to add ice to cool below room temperature, but always allow time for the flask and water to equilibrate before saving a data point.

⑪ Click when you have finished collecting data.

⑫ Record the room temperature (in $^{\circ}\text{C}$) and pressure (in kPa) in your lab notebook.

⑬ Record ALL data points from LoggerPro in your lab notebook.

Part B: Pressure - Volume Relationships

- ① Plug the pressure sensor into Channel 1 of the computer interface.
- ② With the 20 mL syringe disconnected from the pressure sensor, move the plunger of the syringe until the front edge of the inside black ring is positioned at the 10.0 mL mark.
- ③ Attach the 20 mL syringe to the white stem protruding from the end of the pressure sensor with a gentle half-turn.
- ④ Prepare the computer for data collection by opening the appropriate LoggerPro file. The vertical axis should display pressure and the horizontal axis should display volume.
- ⑤ Click ☒ Collect to begin data collection.
- ⑥ Collect the pressure versus volume data. It is probably best for one person to take care of the gas syringe and for another to operate the computer, but you should switch roles during the experiment so that both of you become familiar with the procedure.
 - Move the plunger to position the front edge of the inside black ring at the 5.0 mL line on the syringe. Hold the plunger firmly in this position until the pressure value stabilizes.
 - When the pressure reading has stabilized, click the ☒ Keep button. Type "5.0" in the volume box. Click the OK button to keep this data pair. If you want to redo this point, click on the Cancel button. You should also record the data in your notebook in case your computer crashes during the experiment.
- ⑦ Repeat the step 6 procedure for 6 more volumes between 5.0 and 20.0 mL. Points at volumes below 5 mL are usually not reliable.

⑧ In order to ensure that your results are reliable, repeat at least a couple of your data points. If your data are not reproducible, your system is probably leaking, and you should consult with your instructor for advice. When you are finished collecting data click [stop]

⑨ Record ALL data points from LoggerPro in your lab notebook.

Safety:

Chemical splash goggles must be worn during lab

This experiment uses glassware, ice, and hot water. Hot and cold glass look the same. Use tongs to handle hot glassware. The surface of a hot plate can still be hot even if it is turned off.

Waste disposal:

Water is dumped in the sink.

Part B:

Volume (mL)

Pressure (kPa)

5.0

197.16

7.0

193.96

10.0

190.57

12.0

186.35

15.0

179.12

18.0

166.44

20.0

161.25

Data and Observations

Part A:

Temperature ($^{\circ}\text{C}$)

Pressure (kPa)

Room temp: 20.8°C

Room pressure: 100 kPa

~~100~~ 98.2

101.59

95 94.9

101.89

90.0

100.75

85.0

99.71

80.0

98.94

75.0

97.65

70 69.9

96.53

65 64.9

95.70

60.0

94.04

55.0

92.94

50.0

92.04

45.0

90.25

~~40~~ 39.8

88.96

35.0

87.60

30.2

86.44

25 24.8

84.73

20.0

83.29

15 14.9

81.71

10.0

80.59

5.0

79.38

~~0~~ 4.2

78.39

Part B:

Volume (mL)

Pressure (kPa)

5.0

197.16

7.0

143.96

10.0

100.37

12.0

84.35

15.0

67.32

18.0

56.44

20.0

51.05