TEACHER INFORMATION

Boyle's Law: Pressure-Volume Relationship in Gases

1. Editable Microsoft Word versions of the student pages and pre-configured TI-Nspire files can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. This experiment is written for the Gas Pressure Sensor. The default calibration for this experiment has units of kPa (kilopascals). You can use other units (mm Hg, atm, or psi) by changing them in the data-collection software.

3. In order to save time, you may prefer to do Step 1 of the student procedure prior to the start of class.

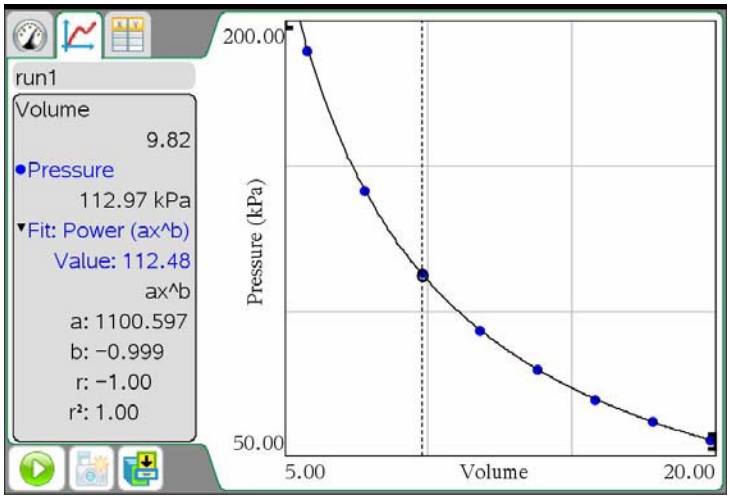
4. As explained in the student procedures, this experiment is written to compensate for the small volume air a chamber inside the Gas Pressure Sensor. The volume of this space is about 0.8 mL. This means that when students enter a volume of 5.0 mL (as read on the syringe), the volume is really about 5.8 mL. To compensate for this error, the students are instructed add 0.8 mL to each of the volumes they enter. By doing this, they will get better results for the value of the exponent, *b*, in Step 6b.

5. Question 8 in the Processing the Data section asks the students to calculate a proportionality constant, *k*, using the equation, $k = P \cdot V$. Your students can do this manually, or you could have them create a calculated column using DataQuest.

SAMPLE RESULTS

Table 1		
Volume (mL)	Pressure (kPa)	Constant, *k* (kPa•mL)
5.8	189.69	1100
7.8	141.75	1105
9.8	113.20	1109
11.8	93.28	1100
13.8	80.22	1107
15.8	69.80	1102
17.8	61.97	1103
19.8	55.87	1106

Table 2 – Values based on Power Fit	
Volume (mL)	Pressure (kPa)
5.0	220.61
10.0	110.24
15.0	73.5
20.0	55.26



Typical graph of Pressure vs. *Volume shown with a power fit.*

ANSWERS TO QUESTIONS

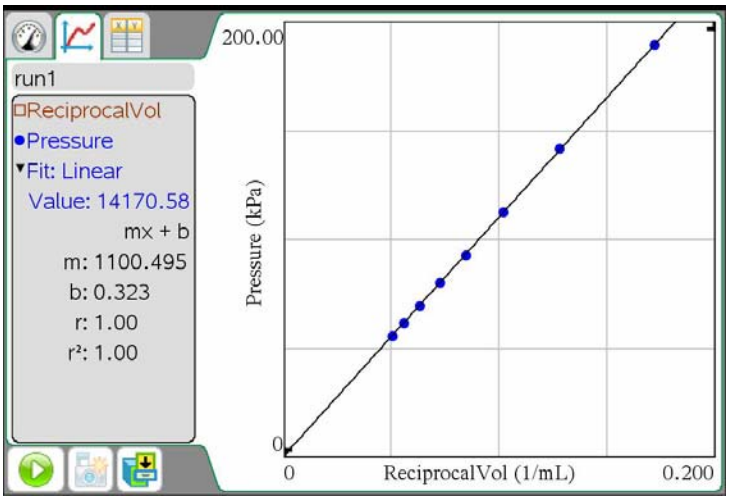
1. When the volume was doubled, the pressure was halved (pressure went from 220.61 kPa to 110.24 kPa).
2. When the volume was halved, the pressure doubled (pressure went from 55.26 kPa to 110.24 kPa).
3. The pressure is reduced by a factor of 1/3 (pressure went from 220.61 kPa to 73.5 kPa).
4. From the data, the relationship appears to be inverse. When pressure data increases, volume data seems to decrease proportionally. The shape of the pressure-volume plot appears to be a simple inverse relationship.
5. If the volume is increased to 40.0 mL, one would expect the pressure to be 1/2 of what it was at 20.0 mL. This would be a pressure of approximately 27 kPa.
6. If the volume were reduced to 2.5 mL, one would expect the pressure to be double what it was at 5.0 mL. This would be a pressure of approximately 440 kPa.
7. The temperature and the number of molecules in the gas sample are assumed to be constant.

8. The correct formula for an inverse relationship is: $k = P \cdot V$. For k values, see the third column of the sample results (1104 kPa•mL is the average value for the constant, k).

9. Values were quite constant, with a very small deviation.

10. The equation representing Boyle's law is: $k = P \cdot V$. The pressure of a confined gas varies inversely with the volume of the gas if the temperature of the sample remains constant.

EXTENSION



Typical graph of Pressure vs. *the Reciprocal of Volume shown with a linear fit.*