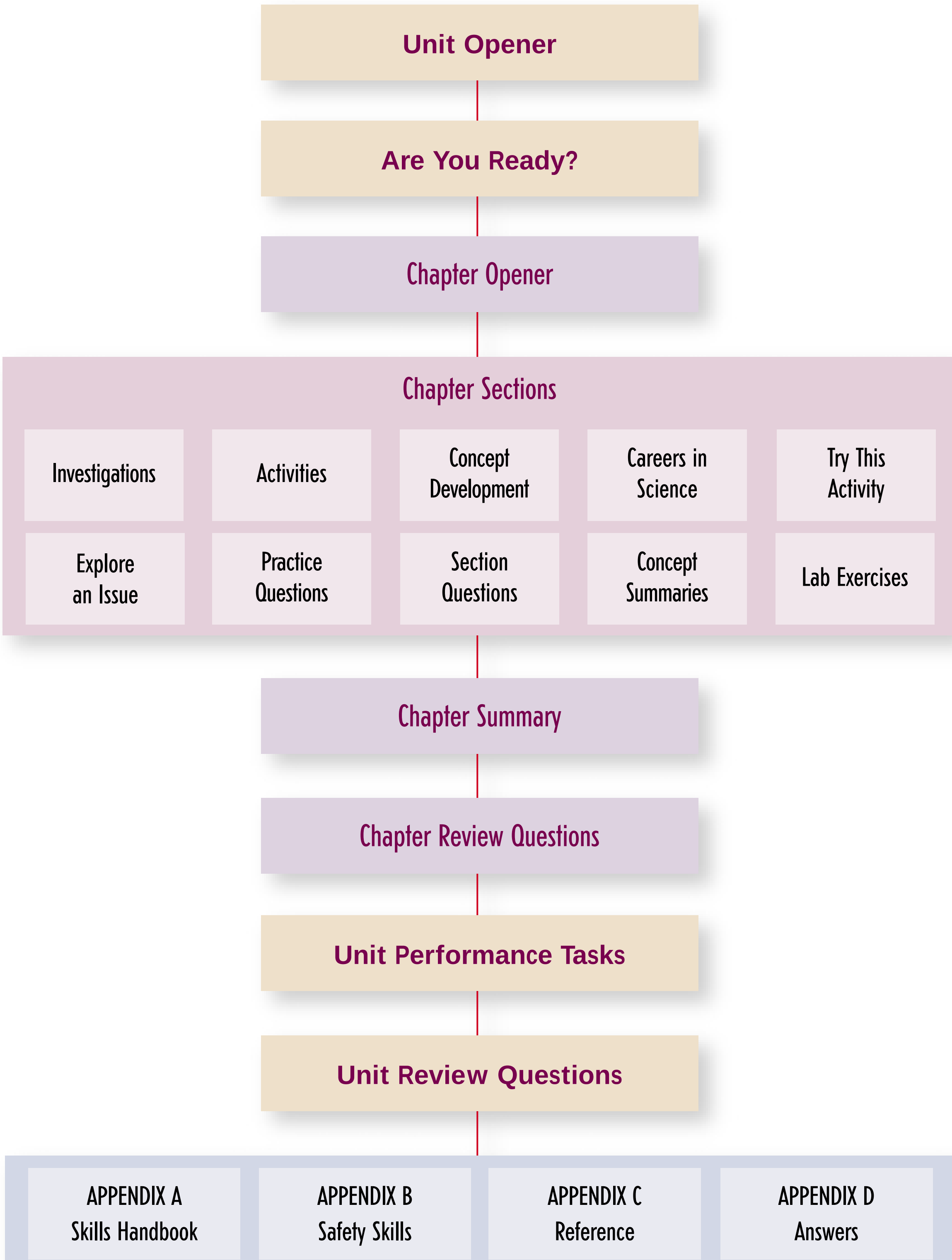
How is *Nelson Chemistry 11* organized into an understandable format for Grade 11 students?

Unit and Chapter Framework

The Student Text is organized into five units with up to four chapters in each unit.



Sample Problems
Sample problems including worked solutions are presented to model the standard of what is expected of students.

Consistent **column width** and use of margin space throughout the text makes it easy to read.

$c_{H_2O_2} = \frac{3\ g}{100\ mL}$

$c_{H_2O_2} = 3\%\ W/V$

In general, we write a percentage weight by volume concentration as

$$c = \frac{m_{solute}}{v_{solution}} \times 100\%$$

A third concentration ratio is the "percentage weight by weight," or % W/W:

$$c = \frac{m_{solute}}{m_{solution}} \times 100\%$$

Sample Problem 2

A sterling silver ring has a mass of 12.0 g and contains 11.1 g of pure silver. What is the percentage weight by weight concentration of silver in the metal?

Solution

$m_{Ag} = 11.1\ g$

$m_{alloy} = 12.0\ g$

$c_{Ag} = \frac{11.1\ g}{12.0\ g} \times 100\%$

$c_{Ag} = 92.5\%\ W/W$

The ring is 92.5 % W/W silver.

Very Low Concentrations

In studies of solutions in the environment, we often encounter very low concentrations. For very dilute solutions we choose a concentration unit to give reasonable numbers for very small quantities of solute. For example, the concentration of toxic substances in the environment or of chlorine in a swimming pool is usually expressed as **parts per million** (ppm, 1:10^6) or even smaller ratios, such as parts per billion (ppb, 1:10^9) or parts per trillion (ppt, 1:10^{12}). These ratios are used for liquid and solid mixtures and are a special case of the weight by weight (W/W) ratio. One part per million of chlorine in a swimming pool corresponds to 1 g of chlorine in 10^6 g of pool water. Because very dilute aqueous solutions are very similar to pure water, their densities are considered to be the same: 1 g/mL. Therefore, 1 ppm of chlorine is 1 g in 10^6 g or 10^6 mL (1000 L) of pool water, which is equivalent to 1 mg of chlorine per litre of water. Small concentrations such as ppm, ppb, and ppt are difficult to imagine, but are very important in environmental studies and in the reporting of toxic effects of substances (Table 1).

We can express the parts per million (ppm) concentration using a variety of units. Choose the one that matches the information given in the example you are calculating. For aqueous solutions,

1 ppm = 1 g/10^6 mL
= 1 g/1000 L
= 1 mg/L
= 1 mg/kg
= 1 µg/g

parts per million: unit used for very low concentrations

Table 1: Parts per Million, Billion, and Trillion

1 ppm	1 drop in a full bathtub
1 ppb	1 drop in a full swimming pool
1 ppt	1 drop in 1000 swimming pools

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6.3

Sample Problem 3

Dissolved oxygen in natural waters is an important measure of the health of the ecosystem. In a chemical analysis of 250 mL of water at SATP, 2.2 mg of oxygen was measured. What is the concentration of oxygen in parts per million?

Solution

$m_{O_2} = 2.2\ mg$

$v_{O_2} = 250\ mL$ or $0.250\ L$

$c_{O_2} = \frac{2.2\ mg}{0.250\ L}$

$= 8.8\ mg/L$

$c_{O_2} = 8.8\ ppm$

The oxygen concentration is 8.8 ppm.

Molar Concentration

Chemistry is primarily the study of chemical reactions, which we communicate using balanced chemical equations. The coefficients in these equations represent amounts of chemicals in units of **moles**. Concentration is therefore communicated using **molar concentration**. Molar concentration, *C*, is the amount of solute in moles dissolved in one litre of solution.

$$\text{molar concentration} = \frac{\text{amount of solute (in moles)}}{\text{volume of solution (in litres)}}$$

$$C = \frac{n}{v}$$

The units of molar concentration (mol/L) come directly from this ratio. The symbol ***C*** denotes a molar quantity, just as ***M*** is molar mass, but ***m*** is mass.

Molar concentration is sometimes indicated by the use of square brackets. For example, the molar concentration of sodium hydroxide in water could be represented by [$NaOH_{(aq)}$].

Sample Problem 4

In a quantitative analysis, a stoichiometry calculation produced 0.186 mol of sodium hydroxide in 0.250 L of solution. Calculate the molar concentration of sodium hydroxide.

Solution

$n_{NaOH} = 0.186\ mol$

$v_{NaOH} = 0.250\ L$

$C_{NaOH} = \frac{0.186\ mol}{0.250\ L}$

$C_{NaOH} = 0.744\ mol/L$

The sodium hydroxide molar concentration is 0.744 mol/L.

mole: the amount of a substance; the number of particles equivalent to Avogadro's number (6.02×10^{23}); the number of carbon atoms in exactly 12 g of a carbon-12 sample; the unit of stoichiometry

molar concentration: the amount of solute, in moles, dissolved in one litre of solution

DID YOU KNOW ?

What's M?

Although it is not an SI unit, some chemists use the unit "molar," M, to express molarity or molar concentration (**Figure 3**). 1 M = 1 mol/L.

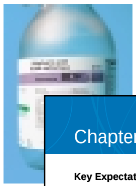

Figure 3
Sulfuric aci…
molar conc…

The Nature an…

Chapter 6 Summary

Key Expectations

Throughout the chapter, you have had the opportunity to do the following:

- Explain the formation of solutions involving various solutes in water and nonpolar solutes in nonpolar solvents. (6.1, 6.2)
- Supply examples from everyday life of solutions involving all three states. (6.1)
- Describe and explain the properties of water, and demonstrate an understanding of its importance as a universal solvent. (6.2)
- Use the terms: solute, solvent, solution, electrolyte, leachate, runoff, concentration, standard solution, stock solution, and dilution. (all sections)
- Solve solution concentration problems using a variety of units. (6.3, 6.5)
- Explain the origins of pollutants in natural waters. (6.4)
- Develop and use the technological skills for the preparation of solutions. (6.5)
- Provide consumer and commercial examples of solutions, including those in which the concentration must be precisely known. (6.5)

Key Terms

acid	intramolecular force
aquifier	landfill leachate
agricultural runoff	molar concentration
aqueous solution	mole
base	neutral
concentrated	nonelectrolyte
concentration	parts per million
dilute	pure water
dilution	solute
dissociation	solution
electrolyte	solvent
homogeneous mixture	standard solution
intermolecular force	stock solution

Make a Summary

1. Make four small concept maps to express each of the following central concepts. Draw them in the corners of a page.
   (a) electrolytes and nonelectrolytes
   (b) calculations related to concentration of solution
   (c) preparation of a solution from a solid solute and by dilution of an existing solution
   (d) the sources of water and pollution and the refining of water

   What central concept or substance can be used to link all of these concept maps? Add this central concept or substance to the centre of the page and link it to the four concept maps prepared above.

Reflect on your Learning

Revisit your answers to the Reflect on Your Learning questions at the beginning of this chapter.

- How has your thinking changed?
- What new questions do you have?

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Key Terms are bolded as they appear in the body of the text and are defined in the side margin. They are repeated in the Chapter Summary and in the Glossary at the end of the text.

Concept/Skill Summary
A point-form summary of the major concepts or skills presented in the section is intended to aid in study. It could be a summary of the steps required to solve a particular class of problems.

… to learn how … the concentration of reactants in solutions. Scientists have developed a concept to help them do this, a concept known as **solution stoichiometry**.

When using the concept of solution stoichiometry, we often know some of the information, such as the mass or concentration of one of the products of a reaction. We can then use this information to determine another quantity, such as the molar concentration of a reactant.

solution stoichiometry: a method of calculating the concentration of substances in a chemical reaction by measuring the volumes of solutions that react completely; sometimes called volumetric stoichiometry

SUMMARY **Stoichiometry Calculations**

When performing any kind of stoichiometry calculation by any method, follow these general steps.

1. Write a balanced equation for the reaction, to obtain the mole ratios.
2. Convert the given value to an amount in moles using the appropriate conversion factor.
3. Convert the given amount in moles to the required amount in moles, using the mole ratio from the balanced equation.
4. Convert the required amount in moles to the required value using the appropriate conversion factor.

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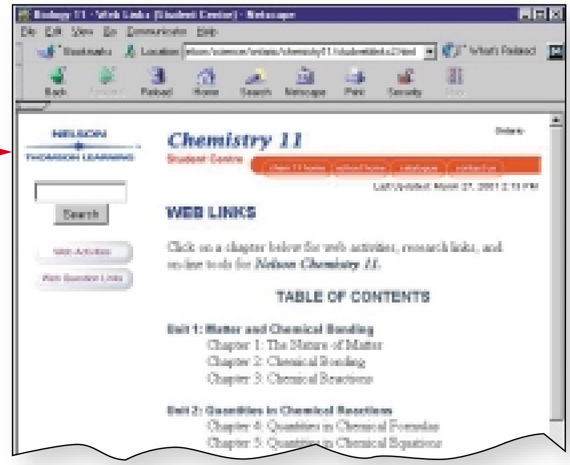
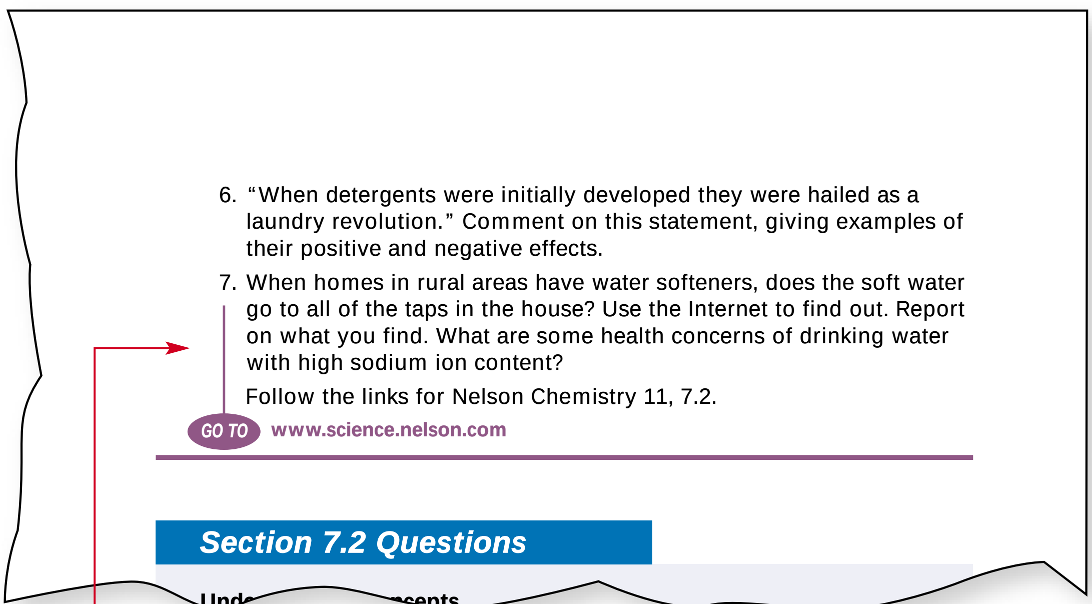
Using a graphic organizer such as a concept map in the **Chapter Summary**, students have the opportunity to summarize key terms and concepts to consolidate understanding.

How does *Nelson Chemistry 11* integrate the use of information technology, laboratory computer interface technology, and the Internet?

Technology

The Nelson Science Web site (www.science.nelson.com) includes “Work the Web” links along with other resources for students, parents, and teachers.





6. “When detergents were initially developed they were hailed as a laundry revolution.” Comment on this statement, giving examples of their positive and negative effects.
7. When homes in rural areas have water softeners, does the soft water go to all of the taps in the house? Use the Internet to find out. Report on what you find. What are some health concerns of drinking water with high sodium ion content?

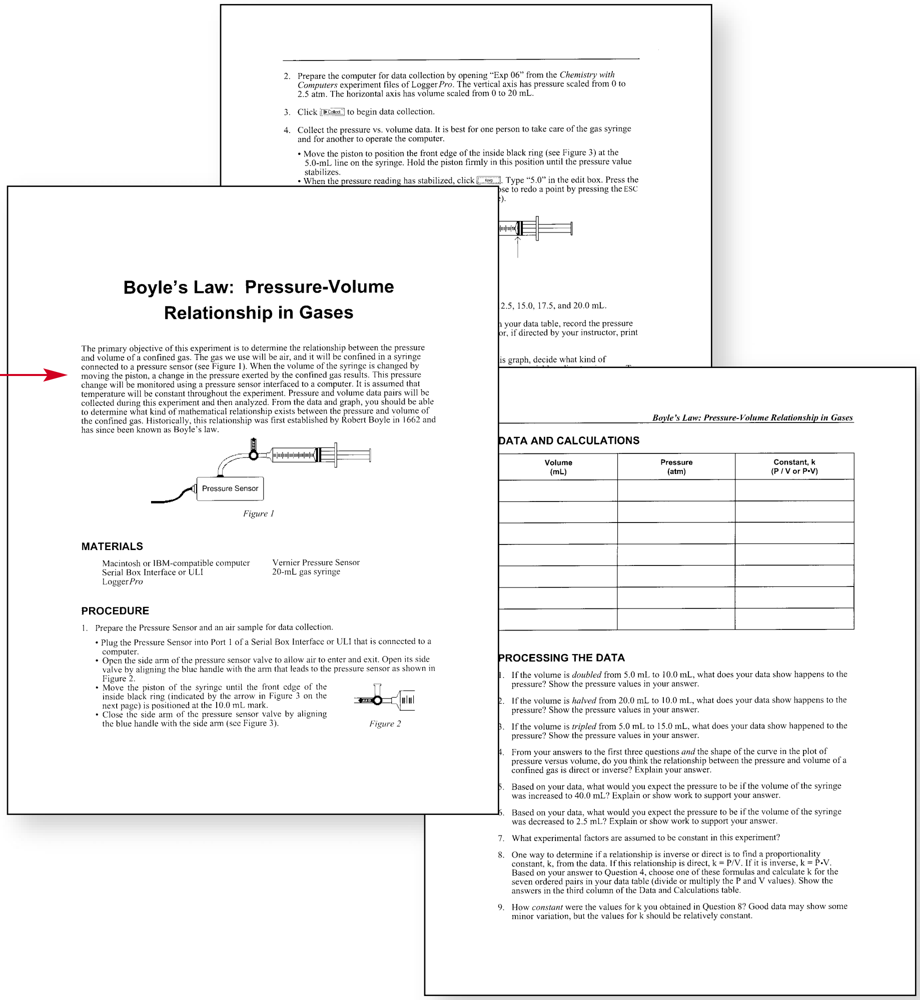
Follow the links for Nelson Chemistry 11, 7.2.

GO TO www.science.nelson.com

Section 7.2 Questions

Web Questions appear periodically throughout the student text. These questions provide students with the opportunity to extend learning by doing further research and engaging in interactive activities on the Internet related to lessons presented in the text. Links to *Explore an Issue* lessons help students to further understand the issue by pointing them to Web sites supporting alternative positions.

Additional investigations and activities that offer students the opportunity to use computer interface laboratory technology are included in the teacher support materials. For each investigation or activity, sample data is provided.



2. Prepare the computer for data collection by opening "Exp 06" from the *Chemistry with Computers* experiment files of Logger*Pro*. The vertical axis has pressure scaled from 0 to 2.5 atm. The horizontal axis has volume scaled from 0 to 20 mL.

3. Click [Collect] to begin data collection.

4. Collect the pressure vs. volume data. It is best for one person to take care of the gas syringe and for another to operate the computer.
   - Move the piston to position the front edge of the inside black ring (see Figure 3) at the 5.0-mL line on the syringe. Hold the piston firmly in this position until the pressure value stabilizes.
   - When the pressure reading has stabilized, click [Keep]. Type "5.0" in the edit box. Press the

Boyle's Law: Pressure-Volume Relationship in Gases

The primary objective of this experiment is to determine the relationship between the pressure and volume of a confined gas. The gas we use will be air, and it will be confined in a syringe connected to a pressure sensor (see Figure 1). When the volume of the syringe is changed by moving the piston, a change in the pressure exerted by the confined gas results. This pressure change will be monitored using a pressure sensor interfaced to a computer. It is assumed that temperature will be constant throughout the experiment. Pressure and volume data pairs will be collected during this experiment and then analyzed. From the data and graph, you should be able to determine what kind of mathematical relationship exists between the pressure and volume of the confined gas. Historically, this relationship was first established by Robert Boyle in 1662 and has since been known as Boyle's law.

Pressure Sensor

Figure 1

MATERIALS

Macintosh or IBM-compatible computer
Serial Box Interface or ULI
Logger*Pro*
Vernier Pressure Sensor
20-mL gas syringe

PROCEDURE

1. Prepare the Pressure Sensor and an air sample for data collection.
   - Plug the Pressure Sensor into Port 1 of a Serial Box Interface or ULI that is connected to a computer.
   - Open the side arm of the pressure sensor valve to allow air to enter and exit. Open its side valve by aligning the blue handle with the arm that leads to the pressure sensor as shown in Figure 2.
   - Move the piston of the syringe until the front edge of the inside black ring (indicated by the arrow in Figure 3 on the next page) is positioned at the 10.0 mL mark.
   - Close the side arm of the pressure sensor valve by aligning the blue handle with the side arm (see Figure 3).

Figure 2

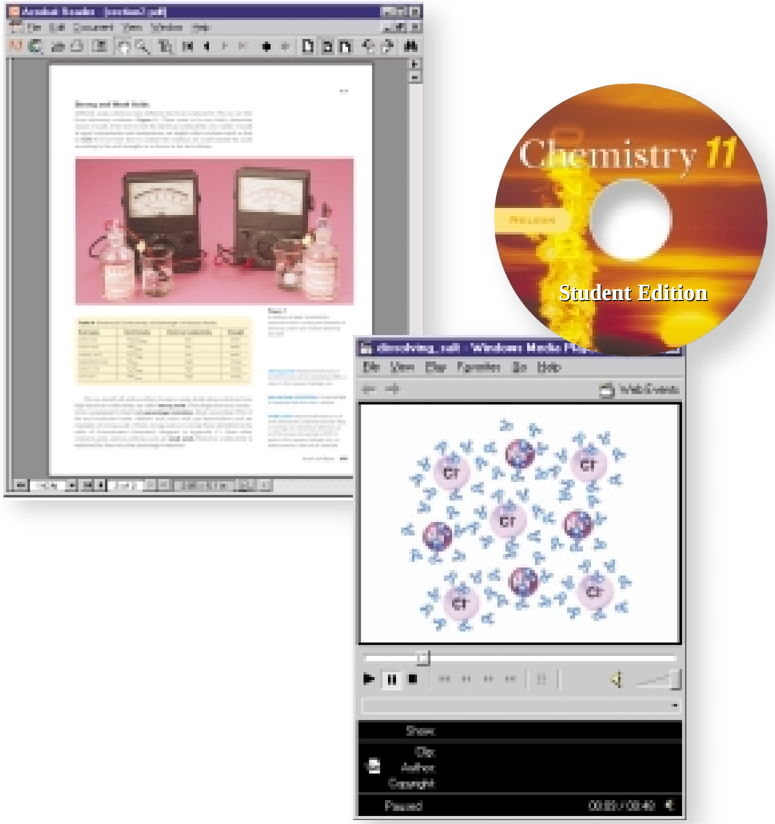
Boyle's Law: Pressure-Volume Relationship in Gases

DATA AND CALCULATIONS

Volume (mL)	Pressure (atm)	Constant, k (P / V or P•V)

PROCESSING THE DATA

1. If the volume is *doubled* from 5.0 mL to 10.0 mL, what does your data show happens to the pressure? Show the pressure values in your answer.
2. If the volume is *halved* from 20.0 mL to 10.0 mL, what does your data show happens to the pressure? Show the pressure values in your answer.
3. If the volume is *tripled* from 5.0 mL to 15.0 mL, what does your data show happened to the pressure? Show the pressure values in your answer.
4. From your answers to the first three questions *and* the shape of the curve in the plot of pressure versus volume, do you think the relationship between the pressure and volume of a confined gas is direct or inverse? Explain your answer.
5. Based on your data, what would you expect the pressure to be if the volume of the syringe was increased to 40.0 mL? Explain or show work to support your answer.
6. Based on your data, what would you expect the pressure to be if the volume of the syringe was decreased to 2.5 mL? Explain or show work to support your answer.
7. What experimental factors are assumed to be constant in this experiment?
8. One way to determine if a relationship is inverse or direct is to find a proportionality constant, k, from the data. If this relationship is direct, k = P/V. If it is inverse, k = P•V. Based on your answer to Question 4, choose one of these formulas and calculate k for the seven ordered pairs in your data table (divide or multiply the P and V values). Show the answers in the third column of the Data and Calculations table.
9. How *constant* were the values for k you obtained in Question 8? Good data may show some minor variation, but the values for k should be relatively constant.



The **Student CD-ROM** not only includes all of the student text, but also additional computer animations.