

How does *Nelson Chemistry 11* match the curriculum?

Balanced Instruction and Assessment

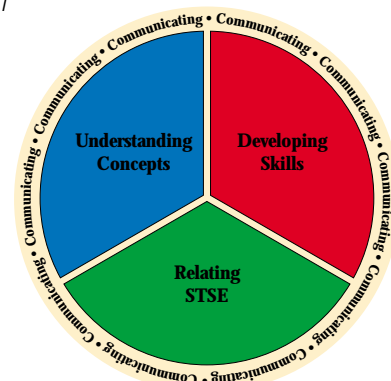
- Nelson Chemistry 11* reflects the overall aim of the secondary science program, which is to “ensure scientific literacy for every secondary school graduate.” (*The Ontario Curriculum, Grades 11 and 12, Science*, p. 6), as well as the primary objective of the *Chemistry, Grade 11, University Preparation* curriculum, which is to “equip students with the knowledge and skills they need to meet the entrance requirements for university programs.”

The Ontario Curriculum, Grades 9 to 12 Program Planning and Assessment, p. 3

- Nelson Chemistry 11* addresses 100% of the *Chemistry, Grade 11, University Science Preparation* (SCH3U) course curriculum expectations
- Nelson Chemistry 11* provides a balance of instruction and assessment, reflecting the three goals of secondary science curriculum, which are:

- Understand the basic concepts of science
- Develop the skills, strategies, and habits of mind required for scientific inquiry
- Relate science to technology, society, and the environment

The Ontario Curriculum, Grades 11 and 12, Science, p. 6



Chapter
4

In this chapter, you will be able to

- explain the law of definite proportions and the significance of different proportions of elements in compounds
- explain the relationship between isotopic abundance and relative atomic mass
- describe and explain Avogadro's constant, the mole concept, and the relationship between the mole and molar mass
- determine empirical and molecular formulas using percentage composition obtained from given data and through experimentation
- describe technological skills for quantitative analysis
- solve problems involving quantities in moles, numbers of particles, and mass numbers

Quantities in Chemical Formulas

When you read the list of ingredients on a package of cereal, do you also notice how much of each ingredient is contained in a serving? We can compare the quantities of sugar or fat or the percentage of daily requirements of vitamins and minerals in different brands (Figure 1). This quantitative information helps us decide which product to select to suit our needs.

Quantities in chemical formulas offer similar important information about the composition and properties of compounds. For example, water (H_2O) and hydrogen peroxide (H_2O_2) both contain the same types of atoms. The only difference is in the number of oxygen atoms. This difference, which appears small, actually results in significant differences in the properties of the two compounds. Water is very stable, can be stored safely for indefinite periods, and can be used for drinking and washing. It is an important ingredient of living cells and is essential for all life on Earth. Hydrogen peroxide, on the other hand, is so unstable that it must be stored in darkened containers to slow its decomposition. Concentrated solutions of hydrogen peroxide must be used with caution, because the chemical reacts readily with other substances and will cause blistering of the skin on contact. Because hydrogen peroxide is toxic it is used to kill bacteria—in low concentrations (0.05%) it is used as an antiseptic to treat minor cuts and abrasions. At higher concentrations (6%) it is used to bleach hair, pulp and paper, and synthetic and natural fibers. At even higher concentrations, its bactericidal properties can be applied as part of the treatment of waste water. At sufficiently high concentrations it is explosive.

How can we determine the chemical composition of a substance? Identifying the substance's properties is one method. In this chapter, you will learn other methods to do this. You will also learn how to measure and communicate quantities when dealing with entities as small as atoms, ions, and molecules.

Reflect your Learning

- The label on a bag of jelly beans states that the bag contains 40% large jelly beans and 60% small jelly beans, by mass. Do you think this information is sufficient if we want to know how many jelly beans of each size there are in the bag? Explain your answer.
- Given your knowledge of chemical reactions, list reasons why you think it is important to be able to communicate information about the number of atoms, ions, or molecules that are reacting or that are produced.
- Many fossil fuels that are burned in factories contain sulfur; when sulfur reacts with oxygen in the air, sulfur oxides—known air pollutants—are produced. Technicians use different methods to predict the masses of these and other chemical reactions that take place. Suggest reasons why it is important to be able to make these predictions. Speculate on how technicians can make this kind of analysis.

Throughout this chapter, note any changes in your ideas as you learn new concepts and develop your skills.

Figure 1
Quantities in a list of ingredients help us compare and select products to suit our needs.

Do Ions Combine in Definite Ratios?

In this activity you will mix copper(II) ions and carbonate ions in different ratios and see how they combine. The solutions of ions will each contain the same number of ions per unit volume.

Materials: lab apron, eye protection, 5 small test tubes of equal size, test-tube rack, eyedropper, 10 mL copper(II) sulfate solution (0.10 mol/L), 10 mL sodium carbonate solution (0.10 mol/L), distilled water.

- Number the test tubes from 1 to 5, and place in the test-tube rack.
- Using the dropper, add drops of copper(II) sulfate solution to each test tube, according to Table 1.
- Wash the dropper thoroughly with distilled water and use the same dropper to add drops of sodium carbonate solution to each test tube, according to Table 1. After you have finished putting drops in each tube, the test tubes should be filled to equal depth since they contain the same number of drops (10 drops total).
- Swirl each test tube gently to mix the contents. Allow the precipitates to settle for about 5 min.
- Wash your hands thoroughly.

(a) What is the ratio of Cu^{2+} ions to CO_3^{2-} ions in each test tube?
(b) Which test tube contains the most precipitate ($CuCO_3$)? What is the ratio of Cu^{2+} ions to CO_3^{2-} ions in this test tube?
(c) From what you learned in Unit 1 about ionic bonds, does this ratio agree with a prediction of how copper(II) ions and carbonate ions would combine to form a compound?
(d) Which test tubes contain the smallest amount of precipitate? Suggest reasons why the ratios of ions in these test tubes produced the least amounts.
(e) What evidence is there that some copper ions remain unused in solution in some tubes?
(f) Explain how the evidence suggests that ions combine in definite ratios.
(g) Dispose of the materials according to your teacher's instructions.

Chapter 4 Summary

Key Expectations

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

- Explain how different stoichiometric combinations of elements in compounds can produce substances with different properties. (4.1)
- Explain the law of definite proportions. (4.1)
- Explain the relationship between isotopic abundance and relative atomic mass. (4.2)
- Demonstrate an understanding of Avogadro's constant, the mole concept, and the relationship between the mole and molar mass. (4.3)
- Use appropriate scientific vocabulary to communicate ideas related to chemical calculations. (4.3, 4.4, 4.5, 4.6, 4.7)
- Solve problems involving quantity in moles, number of particles, and mass. (4.4, 4.5, 4.6, 4.7)
- Determine percentage composition of a compound through experimentation, as well as through analysis of the formula and a table of relative atomic masses. (4.5)
- Give examples of the application of chemical quantities and calculations. (4.5, 4.6, 4.7)
- Distinguish between the empirical formula and the molecular formula of a compound. (4.6, 4.7)
- Determine empirical formulas and molecular formulas, given molar masses and percentage composition or mass data. (4.6, 4.7)

Key Terms

atomic mass unit
Avogadro's constant
dalton
empirical formula
isotopic abundance
law of definite proportions
molar mass
mole
molecular formula
relative atomic mass

The **Chapter Opener** describes the key student expectations for the unit. Curricular expectations are synthesized into an easy-to-understand “student language” format.

The chapter-ending **Summary** feature lists the specific Key Expectations addressed, and points to where the expectations have been addressed in the chapter. The expectations are expressed in the same language used in the curriculum document.

A Understand the Basic Concepts of Science

Nelson Chemistry 11 provides complete and accurate coverage of all content in Ontario's *Chemistry, Grade 11, University Preparation* Science Curriculum (SCH3U). The goal of the program is to adequately prepare students for success in *Chemistry, Grade 12, University Preparation* (SCH4U), and future post-secondary studies. Concepts fundamental to each strand in the curriculum are developed with text and images. Students learn to apply a number of strategies, such as using headings, reading labels, and interpreting diagrams to assist their understanding of concepts.

Specific Expectation Addressed

• demonstrate an understanding of Avogadro's number, the mole concept, and the relationship between the mole and molar mass.

The Ontario Curriculum, Grade 11 and 12, Science, pg. 48

Table 1: Convenient Numbers

| Quantity | Number | Example |
|----------|-----------------------|--------------------------|
| 1 mol | 6.02×10^{23} | 1 mol of atoms |
| 1 mol | 18.02 g | 1 mol of water |
| 1 mol | 32.00 g | 1 mol of oxygen |
| 1 mol | 16.00 g | 1 mol of sulfur |
| 1 mol | 58.00 g | 1 mol of sodium chloride |
| 1 mol | 180.2 g | 1 mol of sucrose |

Avogadro's constant: The number of entities in one mole is 6.02×10^{23} entities.

Example: The amount of substance containing 6.02×10^{23} entities.

Table 2: Avogadro's Constant and the Mole

You are already familiar with some terms used to define convenient numbers (Table 1). For example, a dozen is a convenient number referring to items such as eggs or doughnuts. The number used by chemists to define numbers of entities is called Avogadro's constant (6.02×10^{23} entities/mol). This value is called Avogadro's constant (6.02×10^{23} entities/mol), named after the Italian physicist Amedeo Avogadro (1776–1843), who researched the idea (although an Austrian scientist, J. J. Lomonosov is credited with determining the first reasonable estimate of the number). A mole is the amount of substance containing 6.02×10^{23} of anything, just as a dozen is the amount of substance containing 12 of anything.

- one mole of sodium atoms is 6.02×10^{23} sodium atoms;
- one mole of chlorine molecules is 6.02×10^{23} chlorine molecules;
- one mole of sodium chloride is 6.02×10^{23} formula units of NaCl;
- one mole of elephants is 6.02×10^{23} elephants.

Although the mole represents an extraordinarily large number, a mole of atoms, ions, or molecules is an amount that is observable and convenient to measure and handle. Figure 1 shows a mole of each of three common substances: an element, an ionic compound, and a molecular compound. In each case, a mole of entities is a sample size that is convenient for laboratory work.

Practice

Understanding Concepts

- Explain in your own words what is meant by a mole of a substance.
- What is the numerical value of Avogadro's constant?
- Avogadro's constant is usually written in scientific notation. Express the number in extended form.
- How many molecules are there in 1.00 mol of carbon dioxide?
- How many atoms are there in 5.00 mol of Ar_2 ?
- If one dozen oranges has a mass of 1.43 kg, calculate the mass of a single orange.
- If one mole of hydrogen atoms has a mass of 1.01 g, calculate the mass of a single hydrogen atom.

Answers

- 1.81×10^{24} molecules
- 5.01×10^{24} atoms
- 60 11.9 g
- 1.67×10^{-22} g

Figure 1

These amounts of carbon, table salt, and sugar each contain about a mole of entities (atoms, formula units, molecules, respectively) of the substance. The mole represents a convenient and specific quantity of a chemical.

16 Chapter 4

Concept/Skill Summary

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

Solution

75.33% or 7533 atoms, an C-13
 24.67% or 2467 atoms, an C-12
 $m_{\text{C-13}} = (7533 \times 13 \text{ u}) + (2467 \times 12 \text{ u})$
 $m_{\text{C-13}} = 354.884 \text{ u}$
 $m_{\text{C-12}} = 354.884 \text{ u}$
 $m_{\text{C-12}} = 35.49 \text{ u}$

The average atomic mass of chlorine is 35.49 u.

Practice

Understanding Concepts

- Explain the following concepts:
 - average atomic mass
 - isotopic abundance
 - isotopic composition
- What is the composition of the isotope C-12?
- Explain why the relative atomic mass of carbon, as referenced on the periodic table, is not exactly 12.
- Why would you want to avoid calculating the mass of fractions of an atom?
- Natural potassium consists of 93.10% K-39 and 6.90% K-41. Do these relative values confirm the accepted average atomic mass for natural potassium?
- Natural argon consists of 99.60% Ar-40, 0.34% Ar-36, and 0.06% Ar-38. Do these relative values confirm the accepted average atomic mass for argon?

Lab Exercise 4.2.1

Determination of Relative Atomic Mass

Oxides of nitrogen are formed in any high-temperature combustion that involves air. Thus, car engines produce nitrogen oxides that add to air pollution. In this exercise, mass determinations of each element reacted in the products of an oxide of nitrogen are used to determine the atomic mass of nitrogen relative to oxygen. This is similar to the method of determining relative atomic mass. Use the evidence given to complete the Analysis and Evaluation sections of a lab report.

Figure 2

The mass of one mole of water is 18.02 g. 18.02 g of water contains 6.02×10^{23} molecules.

Figure 3

Moles representing diatomic elements H_2 and Br_2 .

Section 4.2 Questions

Understanding Concepts

- Through experiment, it is determined that an element has a relative atomic mass that is nine times that of a C-12 atom. What element is that atom likely to be?
- Distinguish between the terms atomic mass unit and atomic mass.
- Why is knowledge of the combining proportions of elements in compounds essential to the assigning of relative atomic masses?
- Explain, using an example, how the isotopic abundance of the isotopes of an element is related to the relative atomic mass of the element.
- A naturally occurring sample of boron consists of 19.8% B-10 and 80.2% B-11. Calculate the average atomic mass of this sample of boron.

4.3 The Mole and Molar Mass

Since atoms, ions, and molecules are much too small to see, observable changes in chemical reactions must involve extremely large numbers of these entities. If a product formed from a chemical reaction, we must count the number of atoms and molecules involved. A convenient way of counting large numbers is to use the mole. In this section, we will learn how to do measurement called the mole.

Figure 3

The mass of one mole of water is 18.02 g. 18.02 g of water contains 6.02×10^{23} molecules.

How Many People in One Mole?

continent population: 6 000 000 000
 1 mol of people: 602 000 000 000 000 000 000 000

Did You Know?

molar mass: the mass, in grams per mole, of one mole of a substance. The unit for molar mass is g/mol.

Section 4.3 Questions

Understanding Concepts

- Define Avogadro's constant, and explain its significance in quantitative analysis.
- Distinguish between the terms atomic mass and molar mass.
- Calculate the mass of a molecule of sucrose (sugar, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$) and the mass of a mole of sucrose.
- What is the molar mass of calcium, Ca_{24} , a component of gasoline?

Making Connections

5. One mole of any gas at 0°C and 101 kPa occupies the volume 22.4 L. Use this information and your knowledge of molar mass to determine the density (in grams per litre) of gaseous hydrogen, helium, nitrogen, oxygen, and carbon dioxide in those conditions.

Reflecting

6. You are learning how to calculate molar mass. How do you think this skill will be useful?

4.4 Calculations Involving the Mole Concept

In this section, we will apply the mole concept to a number of situations that we encounter frequently in the study of chemical reactions. Chemical formulas and equations are expressed using amount in moles. In laboratory, we measure mass. So we constantly need to convert amount in moles into mass and vice versa. Think about the terms molar mass. It contains the concepts of both moles and mass. We always use molar mass in connecting the two measurements of amount in moles and mass.

Converting Mass to Amount in Moles

To calculate an amount in moles, we take the given mass in grams and divide by the molar mass. Let's take an example. Each mole of carbon atoms has a mass of 12 g. If we have 24 g of carbon atoms, what is the amount in moles? Since 24 is twice 12, we have 2.0 moles of carbon atoms.

Mathematically, when we divide the mass we are given, 24 g, by the molar mass, 12 g/mol, we get 2.0 mol.

$$\text{Amount in moles} = \frac{\text{mass (g)}}{\text{molar mass (g/mol)}}$$

$$n = \frac{24 \text{ g}}{12 \text{ g/mol}}$$

$$= 2 \text{ mol}$$

Section 4.4 Questions

Understanding Concepts

- Define the term molar mass and state its SI unit.
- What is the molar mass of calcium hydroxide, $\text{Ca}(\text{OH})_2$, a key ingredient in toothpaste?
- What is the molar mass of chlorine, Cl_2 , a poisonous and reactive gas? How is it used in relation to air quality and domestic use?
- What is the molar mass of hydroxide ions, OH^- , present in many bases?
- If the molar mass of atoms of an element was found to be 197.0 g/mol, what element could it be?
- If the molar mass of a substance is 67.2 g/mol, what is the mass of 0.2 mol of the substance?
- What does the term atomic mass mean?
 - Name seven elements that form diatomic molecules.
 - How many molecules are present in one mole of any diatomic element?

Answers

- 79.10 g
- 74.10 g
- 70.90 g
- 107.01 g
- 1.2×10^{24}

Section 4.4 Questions

Answers

1. Write the chemical formula for the substance.
- Determine the number of atoms or ions of each element in one formula unit of the substance.
- Use the atomic molar masses from the periodic table and the amounts in moles to determine the molar mass of the chemical.
- Calculate the molar mass in units of grams per mole (g/mol). In this case, we will calculate molar mass to two decimal places where possible.

Practice

Understanding Concepts

- Define the term molar mass and state its SI unit.
- What is the molar mass of calcium hydroxide, $\text{Ca}(\text{OH})_2$, a key ingredient in toothpaste?
- What is the molar mass of chlorine, Cl_2 , a poisonous and reactive gas? How is it used in relation to air quality and domestic use?
- What is the molar mass of hydroxide ions, OH^- , present in many bases?
- If the molar mass of atoms of an element was found to be 197.0 g/mol, what element could it be?
- If the molar mass of a substance is 67.2 g/mol, what is the mass of 0.2 mol of the substance?
- What does the term atomic mass mean?
 - Name seven elements that form diatomic molecules.
 - How many molecules are present in one mole of any diatomic element?

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Quantity in Chemical Reactions 15

4.4

Did You Know?

Mole Day

Mole Day, which is held in recognition of the mole concept, is celebrated every year on October 23 between 6:02 a.m. and 6:02 p.m.

October 23
 6:02 a.m. to 6:02 p.m.

October 24
 6:02 a.m. to 6:02 p.m.

October 25
 6:02 a.m. to 6:02 p.m.

October 26
 6:02 a.m. to 6:02 p.m.

October 27
 6:02 a.m. to 6:02 p.m.

October 28
 6:02 a.m. to 6:02 p.m.

October 29
 6:02 a.m. to 6:02 p.m.

October 30
 6:02 a.m. to 6:02 p.m.

October 31
 6:02 a.m. to 6:02 p.m.

Quantity in Chemical Reactions 15

B Develop the Skills, Strategies, and Habits of Mind Required for Scientific Inquiry

Investigations, Activities, Lab Exercises (“Dry labs”), and Try This Activities give students the opportunity to develop scientific inquiry and communications skills. “Directed” investigations strategically integrated throughout the text engage students in observing and experimenting. “Open-ended” investigations require students to plan and conduct their own investigations, form hypotheses, or choose their own questions to investigate. *Inquiry Skills Menus* indicate the skills being developed in investigations. Additional lab-based activities, including computer interface labs, are provided in the teacher support materials.

Inquiry Skills Menu

INQUIRY SKILLS

- Questioning
- Hypothesizing
- Predicting
- Planning
- Conducting
- Recording
- Analyzing
- Evaluating
- Communicating

Investigation 9.2.1

Pressure and Volume of a Gas

The purpose of this investigation is to determine the general relationship between the pressure and volume of a gas. Complete the **Design, Evidence, Analysis,** and **Evaluation** sections of the lab report.

Question
What effect does increasing the pressure have on the volume of a gas?

Experimental Design
(a) Using the Procedure and Figure 2, write a brief plan to summarize this experiment.
(b) Identify the independent, dependent, and two controlled variables.
(c) Design a table to record your observations.

Materials
Boyle’s law apparatus or 35 mL plastic syringe
large rubber stopper
cork beer
5 textbooks or equal masses (1 kg)
utility stand
mass balance

Procedure
1. Pull out the syringe plunger so that 30 mL of air is inside the cylinder.
2. If a syringe cap is not provided, bore a small hole deep enough in the rubber stopper so that the tip of the syringe is inside the stopper. This should be a tight fit. Make sure the tip of the syringe does not leak.
3. Hold the syringe barrel vertical and measure the initial volume. Clamp the syringe on a retort stand.
4. While holding the syringe securely, carefully place one textbook or mass on the end of the plunger (Figure 2). (Your partner should balance the mass and be prepared to catch it if it starts to fall.) Record the mass and new volume of air.
5. Repeat step 4 for a total of 4 or 5 books or masses.
6. If time permits, repeat steps 3 to 5 for an additional one or two trials.

Analysis
(a) Plot a graph of gas volume (or average volume from trials) versus mass added and draw a best fit line.
(b) How does changing the mass on the syringe plunger affect the pressure on the air inside the syringe?
(c) According to the evidence you have collected, what effect does increasing pressure have on the volume of a gas?

Evaluation
(d) What are some sources of experimental error or uncertainty in this experiment? In your judgment, are these major or minor problems?
(e) How does your graph provide some indication of experimental errors or uncertainties in this experiment?
(f) Suggest some improvements that might raise the quality of the Evidence. Be as specific as possible.

The Relationship Between Pressure and Volume
Analysis of the evidence produced in an investigation similar to Investigation 9.2.1 suggests an inverse variation between the pressure and the volume of a gas that is, as the pressure increases, the volume decreases (Figure 3). Using the evidence given in SI units in Table 4, you can see that when the pressure is doubled (100 kPa to 200 kPa), the volume is halved (3.00 L to 1.50 L). If the pressure is tripled, the volume is reduced to one-third. Check the other values to see similar results.

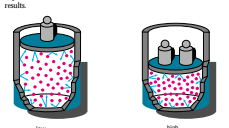


Figure 3
As the pressure on a gas increases, the volume of the gas decreases.

| Pressure (kPa) | Volume (L) | PV (kPaL) |
|----------------|------------|-----------|
| 100 | 3.00 | 300 |
| 200 | 1.50 | 300 |
| 300 | 1.00 | 300 |
| 400 | 0.75 | 300 |
| 500 | 0.60 | 300 |

Boyle’s law: as the pressure on a gas increases, the volume of the gas decreases proportionally, provided that the temperature and amount of gas remain constant. The volume and pressure of a gas are inversely proportional.

For all the conditions listed above, the product of the pressure and volume is equal to P_1V_1 . Mathematically, the relationship is represented as $PV = k$, where k is a constant. This simple relationship was first determined by Robert Boyle in 1662 (Figure 4). Boyle’s law states that as the pressure on a gas increases, the volume of the gas decreases proportionally, provided that the temperature and amount of gas remain constant. In other words, the volume of a gas is inversely proportional to the pressure of the gas, providing that the temperature and amount of gas are held constant. Boyle’s law can be conveniently written comparing any two sets of pressure and volume measurements:

$$P_1V_1 = P_2V_2 \text{ (Boyle’s law)}$$

This can also be expressed as a calculation of a new pressure inversely related to the volumes ratio:

$$P_2 = \frac{P_1V_1}{V_2}$$



Figure 5
Gatorade is a drink that its manufacturer recommends to athletes to replace electrolytes to the body.

evaporation of water. Sweating removes water and the substances dissolved in the water, such as salts and other electrolytes. We replace lost electrolytes by eating and drinking. By law, the ingredients of a food item are required to be placed on the label in descending order of quantity as they are in Gatorade (Figure 5), a rehydrating drink.

(a) Classify the ingredients of Gatorade as electrolytes or nonelectrolytes. How does the number and quantity of electrolytes and nonelectrolytes compare?

(b) Which ingredients contain sodium ions? Which contain potassium ions? Are there more sodium or potassium ions in the drink?

(c) Does the most energy in the drink come from proteins, carbohydrates, or fats (and/or)?

(d) What three chemical needs does the drink attempt to satisfy?

INQUIRY SKILLS

- Questioning
- Hypothesizing
- Predicting
- Planning
- Conducting
- Recording
- Analyzing
- Evaluating
- Communicating

Lab Exercise 6.1.1

Identification of Solutions

For this investigation assume that the labels on the four containers have been removed (perhaps washed off as a flood). Your task as a laboratory technician is to match the labels to the containers, using a litmus indicator and conductivity apparatus to identify the solutions.

You are provided with the **Evidence** gathered. Complete the **Analysis** section of this report.

Question
Which of the solutions labelled 1, 2, 3, and 4 is hydrobromic acid, which is ammonium sulfate, which is lithium hydroxide, and which is methanol?

Experimental Design
Each solution is tested with both red and blue litmus paper and with conductivity apparatus. The temperatures of the solutions and the procedures are controlled.

Evidence

Table 4: Properties of the Unknown Solutions

| Solution | Red Litmus | Blue Litmus | Conductivity |
|----------|------------|-------------|--------------|
| 1 | red | blue | none |
| 2 | red | red | high |
| 3 | red | blue | high |
| 4 | blue | blue | high |

Analysis
(a) Analyze the Evidence and use it to answer the Question: Which of the solutions labelled 1, 2, 3, and 4 is hydrobromic acid, which is ammonium sulfate, which is lithium hydroxide, and which is methanol? Justify your answer.

Lab Exercises (Dry Labs)

give students an opportunity to analyze experimental evidence and answer questions based on the evidence supplied. The students do not actually carry out a “real” experiment. Students may be asked to evaluate the procedure, the experimental design, provide alternatives, and possibly even arrive at a synthesis of ideas using knowledge gained from various previous experiences.

Try This Activity boxes

are short hands-on activities using readily available materials. These activities appear periodically throughout each chapter and give students an informal opportunity for skill development.

Try This Activity

What Makes Popcorn Pop?

In each kernel of popping corn, there is a small drop of water in a circle of soft starch. When heated, the water expands and builds up pressure against the hard outer surface, eventually exploding and turning the kernel inside out.

Materials: popping corn, hot-air popcorn popper, balance

- Measure the mass of some unpopped popping corn.
 - Pop the popping corn.
 - Allow the popcorn to cool and measure the mass again.
 - Assume that any difference in masses is caused by loss of water from the kernels. Calculate the percentage of water in the sample of popcorn.
 - Repeat the activity with kernels of popping corn that have been cut in half either lengthwise or crosswise.
 - Record the percentage of popped kernels from each cutting method.
- (a) Do the results confirm the given reason why popcorn pops? Explain.

Specific Expectation Addressed

• determine through experimentation the quantitative and graphical relationships among the pressure, volume, and temperature of an ideal gas.
Ontario Curriculum, Grades 11 and 12, Science, p. 51

C Relate Science to Technology, Society, and the Environment

The important goal of relating science to technology, society, and the environment (STSE) is integrated throughout the student text and is linked to students' learning of scientific concepts and skills in real-world contexts.

Specific Expectation Addressed

- give examples of the application of chemical quantities and calculations
Ontario Curriculum, Grades 11 and 12, Science, p. 48

Explore an Issue

Debate: Are Natural Vitamins Better for Your Health?

- Visit a health food store and a drugstore and note the sources and costs of different brands of vitamin and mineral supplements. If possible, interview the owner of the store, the pharmacist, and several consumers to find out their opinions.
- In small groups, discuss the issue from several perspectives. Keep notes and organize your ideas into supportive arguments for each side.
- Your teacher will divide the class into two teams for the debate on the resolution "Natural vitamins are better for your health."
- Return to your first group; discuss the issue again and arrive at a position that is agreed upon by every member of the group.
 - (a) Prepare a one-page summary of your group's position on the issue.

Follow the links from Nelson Chemistry 11, 4.7.
GO TO www.science.nelson.com

DECISION-MAKING SKILLS

- | | |
|---|--|
| <ul style="list-style-type: none"> ● Define the Issue ○ Identify Alternatives ● Research | <ul style="list-style-type: none"> ● Analyze the Issue ● Defend the Position ○ Evaluate |
|---|--|

Decision Making Skills Menu

4.7

Investigation 4.7.1

Specific Expectation Addressed

- identify technological products and safety concerns associated with compressed gases.
Ontario Curriculum, Grades 11 and 12, Science, p. 52

9.3 Compressed Gases

Not only are gases a major part of our lives, but compressed gases, that is, gases at pressures above atmospheric pressure, are particularly useful.

- The tires of vehicles contain pressurized air.
- Many people use gas barbecues with a pressurized propane fuel tank.
- Aerosol cans contain a propellant that carries the contents of the can out the nozzle; the propellant is a pressurized gas.
- Major surgery usually involves oxygen administered from a pressurized oxygen tank and is often accompanied by an anesthetic, which may also be a pressurized gas, such as dinitrogen monoxide.

Certain occupations require some work with pressurized gases. In the medical field, paramedics and doctors use oxygen tanks. Firefighters use compressed air tanks like those used by underwater divers. Some welders use oxyacetylene torches (Figure 1). This form of welding requires both a pressurized oxygen tank and a pressurized acetylene tank. Many scientists and their graduate students routinely use pressurized gases for research because the gas is part of the reaction system or because it provides an inert (nonreactive) environment. Noble gases, such as argon, are also used to provide an inert environment in the computer chip industry, where oxygen would cause undesirable reactions.

The chemical safety hazards of some gases are similar to those of many other chemicals, which may be corrosive, toxic, flammable, dangerously reactive, or oxidizing agents. What makes compressed gases much more dangerous is the physical hazard of a potential rocket. In commercial gas cylinders, gas pressures can be as high as 15 MPa (about 150 atm). The hole in the tank, to which the valve stem and valve are connected, is the diameter of a pencil. If the gas is suddenly released through such a small opening, the very great pressure propels the tank, making it a formidable projectile. If the tank is mishandled, dropped, or falls over and the valve stem breaks, the tank can fly through solid brick walls and cause considerable damage.



Figure 14 Geysers are unusual and dramatic examples of geothermal energy used to heat water in a confined space.



Figure 1 The use of a controlled mixture of oxygen and acetylene provides the best conditions and very high temperatures necessary for cutting or welding metal. Note the hose boxes leading to the torch.

Career Solutions

The training requirements for careers that involve solutions vary from high school chemistry for a job as a tree planter to a Ph.D. degree in chemistry for a career in pure research chemistry.



Water-Quality Analyst
A water-quality analyst or technician in a water treatment plant works with aqueous solutions every day. Physical and chemical tests are routinely done to determine the total amount of the raw water and to monitor the quality of the final treated water. Many chemical tests (such as the analysis of dissolved iron ions, calcium ions and chlorides) require the preparation of other reagent (reactant) solutions to conduct the tests. Both solution preparation and reactions in solution are important parts of the job of a water-quality analyst.



Chemistry Teacher

A chemistry or physical science teacher must have a knowledge of solutions, and be able to transfer this ability to the course and many of your previous science courses, you will have some acid solutions in many occasions. At most schools, the teachers prepare the solutions that you use, plan the reactions that you do, and sometimes need to be very successful in cleaning some stains from glassware by reacting the stain with other chemicals such as acids and bases. Chemistry and other physical science teachers need a good understanding of solutions in order to prepare for lab activities. These teachers also do great research in schools and universities.

Environmental Chemist

Environmental chemists often specialize in particular aspects of the air, water, or soil. Many of them use solutions as either reactants or samples in chemical analysis. The concentrations of these samples is usually critically important. This career requires a higher degree of chemistry training than technicians and teachers. To do an environmental researcher requires considerable perseverance and optimism as well as an ability to ask questions and design experiments. Some of the research involves understanding the components and processes in the environment and some research may focus on the nature and effects of pollution.

Practice

Making Connections

2. Choose one of the careers discussed that you might be interested in and use the Internet to research this career. What are the specific educational requirements? Does this occupation require certification by some organization? If so, state the organization. What are the job prospects in this area?

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Specific Expectation Addressed

- identify and describe science- and technology-based careers related to the Solutions and Solubility.
Ontario Curriculum, Grades 11 and 12, Science, p. 45