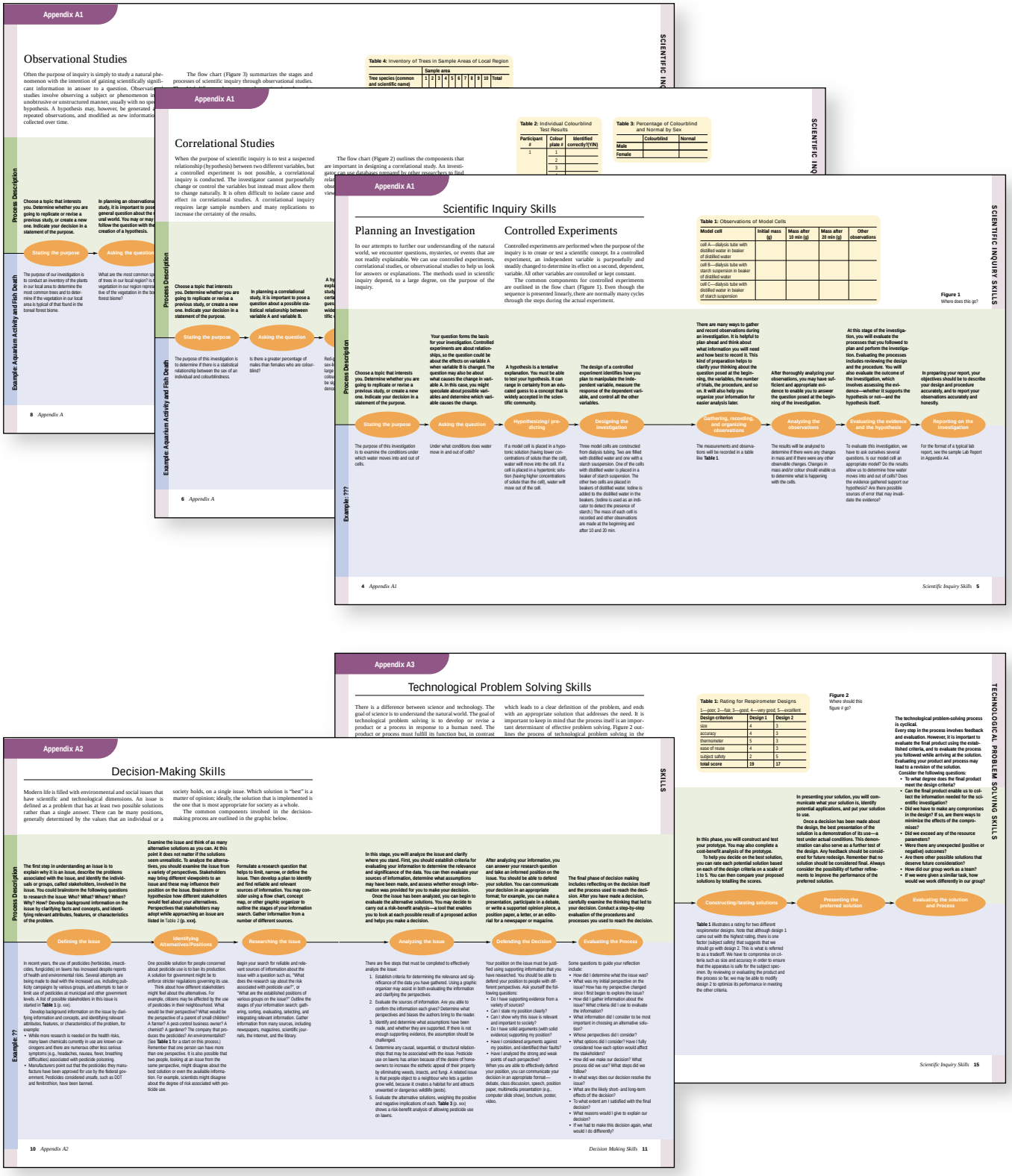
Appendices

The appendices of *Nelson Chemistry 11* are an important feature of the text, enabling students to learn how to learn. The four appendices cover:

- Scientific Inquiry Skills
- Technological Problem Solving
- Decision-Making Skills
- Lab Reports
- Math Skills
- Safety Skills
- Reference Tables
- Answers to Questions



Appendix A4

SKILLS

Lab Reports

When carrying out investigations, it is important that scientists keep records of their plans and results, and share their findings. In order to have their investigations repeated and tested, scientists generally share their work by publishing papers in which details of their design, procedure, evidence, analysis, and evaluation are given.

Lab reports are prepared after an investigation is completed. To ensure that you can accurately describe the investigation, it is important to keep thorough and accurate records of your activities as you carry out the investigation.

Investigators use a similar format in their final reports or lab books, although the headings and order may vary. Your lab book or report should reflect the type of scientific inquiry that you used in the investigation and should be based on the following headings, as appropriate. (See Figure 1 for a sample lab report.)

Title: At the beginning of your report, write the number and title of your investigation. In this course the title is usually given, but if you are designing your own investigation, create a title that suggests what the investigation is about. Include the date of the investigation and the names of your lab partners (if you worked as a team).

Purpose: State the purpose of the investigation. Why are you doing this investigation?

Question: This is the specific question that you attempted to answer in the investigation. If it is appropriate to do so, state the question in terms of independent and dependent variables.

Hypothesis and/or Prediction: Based on your reasoning or on a concept that you have studied, formulate an explanation of what should happen (a hypothesis). From your hypothesis make a prediction, a statement of what you expect to observe, before carrying out the investigation. Depending on the nature of your investigation, you may or may not have a hypothesis or prediction.

Design: This is a brief general overview (one to three sentences) of what was done. If your investigation involved independent, dependent, and controlled variables, list them. Identify any control or control group that was used in the investigation.

Materials: This is detailed list of all materials used, including sizes and quantities where appropriate. Be sure to include safety equipment such as goggles, lab apron, latex gloves, and tongs, where needed. Draw a diagram to show any complicated setup of apparatus.

Procedure: Describe, in detailed step-by-step format, the procedure you followed in carrying out your investigation.

Observations: This includes all qualitative and quantitative observations that you made. Be as precise as possible when describing quantitative observations, include any unexpected observations, and present your information in a form that is easily understood. If you have only a few observations, this could be a list; for controlled experiments and for many observations, a table will be more appropriate.

Analysis: Interpret your observations and present the evidence in the form of tables, graphs, or illustrations, each with a title. Include any calculations, the results of which can be shown in a table. Make statements about any patterns or trends you observed. Conclude the analysis with a statement answering the question that initiated the investigation.

Evaluation: The evaluation is your judgment about the quality of information obtained and about the validity of the prediction and hypothesis (if present). This section can be divided into two parts:

- Did your observations provide sufficient and appropriate evidence to enable you to answer the question?
- Were the prediction and hypothesis supported or rejected by the results?

SKILLS

Investigation 2.5 – The Effect of Concentration on Reaction Time

December 15, 2001

By: Barry L. and Colin B.

Purpose

The purpose of this investigation is to test one of the ideas of the collision–reaction theory.

Question

How does changing the concentration of hydrochloric acid affect the time required for the reaction of hydrochloric acid with a fixed quantity of zinc?

Hypothesis/Prediction

According to the collision–reaction theory, if the concentration of hydrochloric acid is increased, then the time required for the reaction with zinc will decrease. The reasoning that supports the prediction is that a higher concentration produces more collisions per second between the hydrochloric acid particles and the zinc atoms. More collisions per second would produce more reactions per second and therefore, a shorter time required to consume the zinc.

Design

Different known concentrations of excess hydrochloric acid react with zinc metal. The time for the zinc to completely react is measured for each concentration of acid solution. The independent variable is the concentration of hydrochloric acid. The dependent variable is the time for the zinc to be consumed. The temperature of the solution, the quantity of zinc, the surface area of the zinc in contact with the acid, and the volume of the acid are all controlled variables.

Materials

lab apron
(4) 10-mL graduated cylinders
clock or watch (precise to nearest second)
stock solutions of $HCl_{(aq)}$: 2.0 mol/L, 1.5 mol/L, 1.0 mol/L, 0.5 mol/L
safety glasses
(4) 18 × 150-mm test tubes and test-tube rack
four pieces of zinc metal strip (5 mm × 5 mm)
a solution of a weak base (baking soda)

Procedure

1. Put on the lab apron and safety glasses.
2. Transfer 15 mL of 2.0 mol/L $HCl_{(aq)}$ into an 18 × 150-mm test tube.
3. Carefully place a piece of $Zn_{(s)}$ into the hydrochloric acid solution and note the starting time of the reaction.
4. Measure and record the time required for all of the zinc to react.
5. Repeat steps 2 to 4 using 1.5 mol/L, 1.0 mol/L, 0.5 mol/L $HCl_{(aq)}$.
6. Neutralize any acid remaining in the solutions with a solution of the weak base and then pour them down the sink with large amounts of water.

Figure 1
Sample Lab Report

Appendix B1

SAFETY SKILLS

Safety Skills

Although every effort is made to ensure that the science experience is safe, there are some inherent risks. These risks are generally associated with the materials and equipment used, and with disregard of safety instructions when conducting investigations. There may also be risks associated with the location of the investigation. Most of these risks pose no more danger than what is normally experienced in everyday life. With an awareness of the possible hazards, knowledge of the rules, appropriate behaviour, and common sense, these risks can be practically eliminated.

Remember, you share the responsibility not only for your own safety, but also for the safety of those around you. Always alert the teacher in case of an accident.

In this text, chemicals, equipment, and procedures that are hazardous are highlighted in red and are preceded by the appropriate Workplace Hazardous Materials Information System (WHMIS) symbol or by .

Safety Conventions and Symbols

WHMIS Symbols and HHPS

The Workplace Hazardous Materials Information System (WHMIS) provides workers and students with complete and accurate information regarding hazardous products. All chemical products supplied to schools, businesses, and industries must contain standardized labels and be accompanied by a Material Safety Data Sheet (MSDS) providing detailed information about the product. Clear and standardized labelling is an important component of WHMIS (Table 1). These labels must be present on the product's original container and added to other containers if the product is transferred.

The Canadian Hazardous Products Act requires manufacturers of consumer products containing chemicals to include a symbol specifying both the nature of the primary hazard and the degree of this hazard. In addition, any secondary hazards, first-aid treatment, storage, and disposal must be noted. Household Hazardous Product Symbols (HHPS) are used to show the hazard, and the degree of the hazard is indicated by the type of border surrounding the illustration (Figure 1).

CORROSIVE
This material can burn your skin and eyes. If you swallow it, it will damage your throat and stomach.

FLAMMABLE
This product or the gas (or vapour) from it can catch fire quickly. Keep this product away from heat, flames, and sparks.

EXPLOSIVE
Container will explode if it is heated or if a hole is punched in it. Metal or plastic can fly out and hurt your eyes and other parts of your body.

POISON
If you swallow or lick this product, you could become very sick or die. Some products with this symbol on the label can hurt you even if you breathe (or inhale) them.

Figure 1
Household Hazardous Product Symbols

Appendix B

SAFETY SKILLS

Table 1: WHMIS Symbols

Class and type of compounds	WHMIS symbol	Risks	Precautions
class A: compressed gas (material that is normally gaseous and kept in a pressurized container)		• could explode due to pressure • could explode if heated or dropped • possible hazard from both the force of explosion and the release of contents	• ensure container is always secured • store in designated areas • do not drop or allow to fall
class B: flammable and combustible materials (materials that will continue to burn after being exposed to a flame or other ignition source)		• may ignite spontaneously • may release flammable products if allowed to degrade or when exposed to water	• store in properly designated areas • work in well-ventilated areas • avoid heating • avoid sparks and flames • ensure that electrical sources are safe
class C: oxidizing materials (materials that can cause other materials to burn or support combustion)		• can cause skin and eye burns • increase fire and explosion hazard • may cause combustibles to explode or react violently	• store away from combustibles • wear body, hand, face, and eye protection • store in proper container that will not rust or oxidize
class D: toxic materials—immediate and severe (poisons and potentially fatal materials that cause immediate and severe harm)		• may be fatal if ingested or inhaled • may be absorbed through the skin • small volumes have a toxic effect	• avoid breathing dust or vapours • avoid contact with skin and eyes • wear protective clothing, and face and eye protection • work in well-ventilated areas and wear breathing protection
class D: toxic materials— long term concealed (materials that have a harmful effect after repeated exposures or over a long period)		• may cause death or permanent injury • may cause birth defects or sterility • may cause cancer • may be sensitizers causing allergies	• wear appropriate personal protect • work in a well-ventilated area • store in appropriate designated ar • avoid direct contact • use hand, body, face, and eye prote • ensure respiratory and body prote is appropriate for the specific haz
class D: biohazardous infectious materials (infectious agents or a biological toxin causing a serious disease or death)		• may cause anaphylactic shock • includes viruses, yeasts, moulds, bacteria, and parasites that affect humans • includes fluids containing toxic products • includes cellular components	• special training is required to han materials • work in designated biological area with appropriate engineering cont • avoid forming aerosols • avoid breathing vapours • avoid contamination of people/an • store in special designated areas
class E: corrosive materials (materials that react with metals and living tissue)		• eye and skin irritation on exposure • severe burns/tissue damage on longer exposure • lung damage if inhaled • may cause blindness if contacts eyes • environmental damage from fumes	• wear body, hand, face, and eye protection • use breathing apparatus • ensure protective equipment is appropriate • work in a well-ventilated area • avoid all direct body contact • use appropriate storage container ensure proper nonreacting closure
class F: dangerously reactive materials (materials that may have unexpected reactions)		• may react with water • may be chemically unstable • may explode if exposed to shock or heat • may release toxic or flammable vapours • may vigorously polymerize • may burn unexpectedly	• handle with care, avoiding vibrati shocks, and sudden temperature changes • store in appropriate containers • ensure storage containers are sol • store and work in designated area

Appendix A6

MATH SKILLS

Math Skills

Scientific Notation

It is difficult to work with very large or very small numbers when they are written in common decimal notation. Sometimes it is possible to accommodate such numbers by changing the SI unit so that the number falls between 0.1 and 1000; for example, 237 000 000 mm can be expressed as 237 km and 0.000 895 kg can be expressed as 0.895 g. However, this unit change is not always possible, either because an appropriate unit does not exist or because it is essential to use a particular unit of measurement. In these cases, the best method of dealing with very large and very small numbers is to write them using scientific notation. Scientific notation expresses a number by writing it in the form $a \times 10^n$, where $1 < |a| < 10$ and the digits in the factor a are all significant. Table 1 shows situations where scientific notation could be used.

Table 1: Examples of Scientific Notation

Expression	Common decimal notation	Scientific notation
134.5 million kilometres	134 500 000	1.345×10^8 km
154 picometres	0.000 000 000 154	1.54×10^{-10} m
602 sextillion particles/mole	602 000 000 000 000 000 000 000	6.02×10^{23} particles/mol

To multiply numbers in scientific notation, multiply the real numbers and add the exponents; the answer is expressed in scientific notation. To divide numbers in scientific notation, divide the real numbers and subtract the exponent of the denominator from the exponent of the numerator; the answer is expressed in scientific notation. Note that when writing a number in scientific notation, the simple number must be between 1 and 10, and is rounded to the same number of significant digits as the measurement with the fewest number of significant digits. Look at the following examples:

$$(4.73 \times 10^5)(5.82 \times 10^7) = 27.5 \times 10^{12} = 2.75 \times 10^{13}$$
$$(3.9 \times 10^6) \div (5.3 \times 10^{-1}) = 0.74 \times 10^7 = 7.4 \times 10^6$$

On many calculators, scientific notation is entered using a special key, labelled EXP or EE. This key includes "× 10" from the scientific notation; you need to enter only the exponent. Here are two examples:

To enter 7.5×10^4 press **7.5 EXP 4**.
To enter 3.6×10^{-3} press **3.6 EXP +/- 3**.

Uncertainty in Measurements

There are two types of initial quantities that are used in science: exact values and measurements. Exact values include defined quantities (1 m = 100 cm) and counted values (5 cars in a parking lot). Measurements, however, are not exact because there is some uncertainty or error associated with every measurement.

There are two types of uncertainty or error. Random error results when an estimate is made to obtain the last significant figure for any measurement. The size of the random error is determined by the precision of the measuring instrument. For example, when measuring length, it is necessary to estimate between the marks on the metre stick. If these marks are 1 cm apart, the random error will be greater and the precision will be less than if the marks are 1 mm apart.

Systematic error is associated with an inherent problem with the measuring system, such as the presence of an interfering substance, incorrect calibration, or operator error. For example, if the balance is not zeroed at the beginning, all measurements will have an error; if using a metre stick that has been worn slightly, all measurements will contain an error.

Sometimes the measurements may be very precise because of the gradations of the measuring device. Precision is the place value of the last measurable digit and is determined by the refinement of the scale on the measuring instrument. For example, a measurement of 12.74 cm is more precise than a measurement of 127.4 cm because the first value measures to the hundredths of a centimetre whereas the latter measures to the tenth of a centimetre. When adding or subtracting measurements of different precision, the answer is rounded to the same precision as the least precise measurement. Here is an example:

11.7 cm + 3.29 cm + 0.542 cm = 15.532 cm

The answer must be rounded to 15.5 cm because the first measurement limits the precision to a tenth of a centimetre.

No matter how precise a measurement is, it still may not be accurate. Accuracy refers to how close a value is to its true value. The comparison of the two values can be expressed as a percentage difference. The percentage difference is calculated as follows:

$$\%\ \text{difference} = \frac{|\text{measured value} - \text{true value}|}{\text{true value}} \times 100$$

Appendix C

REFERENCE DATA TABLES

Reference Data Tables

Table 1:
Numerical Prefixes: Powers and Subpowers of Ten

Prefix	Power	Symbol
deca	10^1	da
hecto	10^2	h
kilo	10^3	k
mega	10^6	M
giga	10^9	G
tera	10^{12}	T
peta	10^{15}	P
exa	10^{18}	E
deci	10^{-1}	d
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	μ
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{-18}	a

Table 2:
Numerical Prefixes: Common Multiples

Multiple	Prefix
$\frac{1}{2}$	hemi-
1	mono-
$1\frac{1}{2}$	sesqui-
2	bi-, di-
$2\frac{1}{2}$	hemipenta-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

SI Units

Throughout the text and in this reference section, we have attempted to be consistent in the presentation and usage of units. As far as possible, the text uses the International System (SI) of Units. However, some other units have been included because of their practical importance, wide usage, or use in specialized fields. For example, Health Canada and the medical profession continue to use millimetres of mercury (mm Hg) as the units for measurement of blood pressure, although the Metric Practice Guide indicates that this unit is not to be used with the SI.

The most recent Canadian Metric Practice Guide (CAN/CSA-Z234.1-89) was published in 1989 and reaffirmed in 1995 by the Canadian Standards Association.

Other data in this reference section has been taken largely from Lange's Handbook of Chemistry, Fifteenth Edition, McGraw-Hill, 1999.

Table 3:
SI Base Units

Quantity	Symbol	Unit name	Abbreviation
amount of substance	n	mole	mol
electric current	I	ampere	A
length	L, l, h, d, w	metre	m
luminous intensity	I_v	candela	cd
mass	M	kilogram	kg
temperature	T	kelvin	K
time	t	second	s

Table 4:
Some SI Derived Units

Quantity	Symbol	Unit	Unit Symbol	SI Base Unit
acceleration	a	metre per second per second	m/s^2	m/s^2
area	A	square metre	m^2	m^2
density	ρ, D (pref)	kilogram per cubic metre	kg/m^3	kg/m^3
displacement	d	metre	m	m
electric charge	Q, q, e (pref)	coulomb	C	A·s
electric potential	V	volt	V	$kg \cdot m^2/A \cdot s^3$
electric field	E	volt per metre	V/m	$kg \cdot m/A \cdot s^3$
electric field intensity	E	newton per coulomb (Tesla)	N/C (T)	$kg/A \cdot s^2$
electric resistance	R	ohm	Ω	$kg \cdot m^2/A^2 \cdot s^3$
energy	E, E_k, E_p	joule	J	$kg \cdot m^2/s^2$
force	F	newton	N	$kg \cdot m/s^2$
frequency	f	hertz	Hz	s^{-1}
heat	Q	joule	J	$kg \cdot m^2/s^2$
magnetic flux	Φ	weber	Wb	$kg \cdot m^2/A \cdot s^2$
magnetic field	B	weber per square metre (Tesla)	T	$kg/A \cdot s^2$
momentum	p, p (pref)	kilogram metre per second	kg·m/s	$kg \cdot m/s$
period	T	second	s	s
power	P	watt	W	$kg \cdot m^2/s^3$
pressure	P, p	newton per square metre	N/m^2	$kg/m \cdot s^2$
speed	v	metre per second	m/s	m/s
velocity	$\vec{v}$	metre per second	m/s	m/s
volume	V	cubic metre	m^3	m^3
wavelength	λ	metre	m	m
weight	W, w (pref)	newton	N	N, $kg \cdot m/s^2$
work	W	joule	J	$kg \cdot m^2/s^2$