Unit 1: Chemical Reactions
Specific Curriculum Outcomes

Suggested Time: 60 Hours

Unit Overview

Introduction

After students have developed an understanding of atomic structure and the periodic table in grade 9, the study of chemical reactions provides them with an opportunity to apply their understanding of atomic structure to how chemicals react. By naming and writing common ionic and molecular compounds, and by balancing a variety of equation types, students begin to make connections to a variety of chemical examples in everyday life.

Focus and Context

This unit emphasizes the social and environmental contexts of science and technology associated with air and water pollution, and should have a principal focus of **observation** and **inquiry**. However, there are opportunities for **decision making** as well as **design technology** in the laboratory research components of this unit. Atlantic Canada offers a possible context for this unit because it is particularly affected by acid precipitation and other forms of air pollution owing to prevailing winds in North America. These winds carry large amounts of air pollutants from the more populated and industrialized regions of the United States and Canada. The problem is further complicated by our own industrial plants and power generation plants. In addition, much of our region has thin soils and granite bedrock, which results in a high sensitivity to acid damage. In this context students will consider how chemical reactions are associated with technologically-produced problems such as acid rain, and look at some steps that can be taken to counter the effects of acid rain.

Science Curriculum Links

The study of chemical reactions in Level I connects readily with topics covered as early as primary, where students are introduced to chemical/physical properties, liquids and solids and the nature of chemical change. These early considerations of states of matter are given more attention and detail in elementary as properties and changes in materials are studied. By grade 7, students cover in some detail the concept of mixtures and solutions. As mentioned in the above paragraph, there are very strong links between the topics of atomic structure in grade 9 and the chemistry studied in Level I. For those who pursue chemistry in Level II and Level III, the material covered in grades 7, 9 and Level I offers a solid foundation to build on as students undertake a more detailed look at traditional chemistry topics such as acids and bases, solutions, stoichiometry, and electrochemistry.

Curriculum Outcomes

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **114-2** explain the roles of evidence, theories, and paradigms in the development of scientific knowledge **114-8** describe the usefulness of scientific nomenclature systems **Relationships Between Science and Technology** **116-6** describe and evaluate the design of technological solutions and the way they function using principles of energy and momentum **Social and Environmental Contexts of Science and Technology** **117-1** compare examples of how society supports and influences science and technology **117-5** provide examples of how science and technology are an integral part of their lives and their community **117-7** identify and describe science- and technology-based careers related to the science they are studying **118-2** analyze from a variety of perspectives the risks and benefits to society and the environment of applying scientific knowledge or introducing a particular technology **118-9** propose a course of action on social issues related to science and technology, taking into account human and environmental needs **Initiating and Planning** **212-3** design an experiment identifying and controlling major variables **212-4** state a prediction and a hypothesis based on available evidence and background information **212-8** evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making	*Students will be expected to* **Performing and Recording** **213-3** use instruments effectively and accurately for collecting data **213-5** compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data **213-8** select and use apparatus and materials safely **213-9** demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials **Analyzing and Interpreting** **210-1** use or construct a classification key **210-16** identify new questions and problems that arise from what was learned **214-3** compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots **214-5** interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables **214-6** apply and assess alternative theoretical models for interpreting knowledge in a given field **214-11** provide a statement that addresses the problem or answers the question investigated in light of the link between data and the conclusion **214-12** explain how data support or refute the hypothesis or prediction **214-13** identify and correct practical problems in the way a technological device or system functions **214-14** construct and test a prototype of a device or system and troubleshoot problems as they arise **214-18** identify and evaluate potential applications of findings	*Students will be expected to* **300-10** identify properties such as texture, hardness, flexibility, strength, buoyancy, and solubility that allow materials to be distinguished from one another **307-14** use models in describing the structure and components of atoms and molecules **319-1** name and write formulae for some common ionic and molecular compounds, using the periodic table and a list of ions **319-2** classify substances as acids, bases, or salts, based on their characteristics, name, and formula **321-1** represent chemical reactions and the conservation of mass, using molecular models and balanced symbolic equations **321-2** describe how neutralization involves tempering the effects of an acid with a base or vice versa **329-3** explain the relationship between the energy levels in Bohr's model, the energy difference between the levels, and the energy of the emitted photons **NLS-1** describe alchemy and compare the alchemy of early civilizations and the Middle Ages to the practice of chemistry today

Chemistry Around You

Outcomes

Students will be expected to

- provide examples of how science and technology are an integral part of their lives and their community by investigating common examples of combustion (117-5)
  - define matter
  - define chemistry

Elaborations—Strategies for Learning and Teaching

Students will have encountered many of the terms and concepts in previous grades. The aim of this section is to review and then build upon the concepts/information students have mastered in previous grades.

The student textbook states that chemistry is the study of chemicals, their properties, and changes that take place between chemicals. More correctly, chemistry is the study of matter. Matter may be defined as anything that has mass and occupies space. In effect, everything in our universe is matter. The only exceptions to this are forms of energy (e.g., light, heat, radiation and electricity). Teachers could begin this section by asking students to provide a definition of matter. Many will recall the “anything that has mass and occupies space” definition from earlier grades. Teachers could probe a bit further to help students develop an understanding of what this definition actually means. Questions to ask could include: What are some examples of matter? Are there examples of things that are not matter? [Star Trek fans might mention “antimatter”. There is no real evidence that antimatter (i.e. matter that has the opposite properties of matter) exists. It is a theoretical concept upon which many science fiction authors create story lines.]

Students may suggest that the air around us is not matter because it “doesn’t weigh anything” (or they can not “feel” its weight). To show that air does have mass (weight) use an inflated balloon demonstration (e.g. weigh an empty balloon; blow it up fully and then reweigh it; subtract the first measurement from the second; the difference is the weight due to air you put in the balloon).

Scientists often argue, usually in jest, whether their branch of science is “better”, more interesting or explains more observations. Students could research several branches of science, i.e., biology, chemistry, physics, geology, to provide brief definitions. Through their research, students will realize that each branch of science is subdivided. For example, chemistry is often divided into organic chemistry (the study of chemicals in living, or once living, things), inorganic chemistry (the study of chemicals that contain metals and nonmetals- more on this later), analytical chemistry (the study of identifying what is in a substance and measuring how much of it is there), and physical chemistry (the study of energy and its relationship with matter). This could help highlight what chemistry is about and how it can be distinguished from the other sciences. Students could set up a mini-debate to argue which is “best”. Students should consider difficulty of subject matter, connectedness to other disciplines, impacts on society, relationship to Newfoundland and Labrador, and career opportunities.

Chemistry Around You

Suggested Assessment Strategies

Journal

- Students could write examples of the different types of matter they encounter at school and at home. (117-5)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

TR: 12-7

SRL:

ST: pp. 70-299

TR: 2-7

SRL:

Chemistry Around You *(continued)*

Outcomes

Students will be expected to

- provide examples of how science and technology are an integral part of their lives and their community by investigating common examples of combustion (117-5) **Cont'd**
  - identify examples of chemistry and technology around them in everyday life

Elaborations—Strategies for Learning and Teaching

Teachers could ask students to provide examples of "chemistry" from their everyday lives. Teachers should direct the students to consider a wide range of areas. Every substance that exists in the natural world can be studied from a chemical perspective and can be explained through a study of its properties (chemical and physical: see later). All living things have thousands of chemical reactions that are occurring in their bodies (e.g. digesting of food, repairing of cells, clotting of blood, removing poisons from the blood, etc.). All synthetic or "man-made" substances are a product of chemical reactions (for example, plastics, drugs, rubbers and fabrics). Cooking is another excellent example of chemistry in action. Careful measuring, mixing, and heating are all common chemistry activities.

Teachers could challenge students to describe a day in which they never touch or use plastics (or other synthetic compound). They would soon realize how different and challenging that day would be. This challenge will help students realize the significance of chemistry in their lives. In essence, the teacher could ask the question, "what in the world isn't chemistry?" and not receive any examples!

- identify new questions and problems that arise from what was learned (210-16)
- identify and describe science and technology-based careers related to the study of chemistry (117-1)

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 117-5, 210-16, 117-1 and their delineations. The STSE component, *What in the World is Chemistry?*, can be found in Appendix A.

Chemistry Around You *(continued)*

Suggested Assessment Strategies

Presentation

- Working in pairs, students could develop a short presentation about the importance of chemistry in their daily lives. (117-5, 215-6)
- Students could create a collage, poster, or multimedia presentation using photos, etc., they collect from magazines, Internet, etc. (117-5, 213-5)

Portfolio

- Students could collect samples that depict the role of chemistry or the importance of chemistry in our society from newspapers, magazines, Internet, etc. Appropriate samples would include photos, articles, news clips, etc. (117-5, 213-6)

Journal

- Students could list at least 5 examples of chemistry in their daily lives. (117-5)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 70 → 75

SRL: 100 → 107

TR: 1-8 → 2-11

BLM: 2-3 (2.1a)

Core STSE #1: *What in the World is Chemistry?,* **Appendix A**

Chemistry Around You *(continued)*

Outcomes

Students will be expected to

- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials (213-9)
  - describe the WHMIS information system and its use
  - identify the eight WHMIS symbols
  - identify the hazardous household product symbols
  - distinguish between WHMIS symbols and hazardous household product symbols
  - describe the MSDS sheet and its use
  - identify the nine categories on a MSDS sheet
  - recognize the hazards associated with several consumer products. Include examples from:
    - (i) household cleaners
    - (ii) automotive products
    - (iii) paint products
    - (iv) pesticides
  - select examples of consumer products and compare hazardous household product symbols to their WHMIS symbols
  - use previous examples and examine their MSDS's (Material Safety Data Sheets) to determine:
    - (i) safe storage
    - (ii) safe handling
    - (iii) first aid measures

Elaborations—Strategies for Learning and Teaching

Students should be encouraged to consider why there are so many "chemical products" used by consumers. They should develop the understanding that various products (chemicals) are used depending on its purpose (i.e. different jobs require chemicals with different properties). For example, Teflon's "slippery" property makes it ideal for cooking utensils, or, titanium's strength and light weight make it an excellent metal for aircraft production.

Students could be required to inventory the various chemicals they have in their home (kitchen/bathroom, garage, and garden) and use BLM's 2.1a to record their data. If teachers choose to do this activity, they should first ensure students are familiar with the HHPS (Hazardous Household Product Symbols) safety warnings symbols. Such an inventory could be used as the basis for discussing the outcomes in this section. Teachers could ask students to do the "A Household Hazardous Products Inventory" activity (page 74 of ST) to help students recognize the most dangerous places in their home. They could develop an action plan for their family that could include ways to store and dispose of these chemicals as well as first aid treatments.

Students will have been introduced to the Workplace Hazardous Materials Information System (WHMIS) as well as Hazardous Household Product Symbols (HHPS) in Science 2200. (If not, teachers may need to spend more time covering these outcomes.) Students are expected to apply this system when they handle or work with chemicals during laboratory activities.

Chemistry Around You *(continued)*

Suggested Assessment Strategies

Portfolio

- Using the Internet (or magazines) students could collect samples of labels from a variety of chemicals found in households, automotive settings, painting, and/or lawn care (pesticides/herbicides). Using these they could create a poster that outlines one of the following: safe storage, precautions or protective equipment required, or first aid treatments. (213-6, 213-9)

Paper and Pencil

- Students could make a list of the chemicals found in their homes. In a group, they could divide up the list and check the MSD sheets to see how these chemicals should be handled and stored. Their findings could be collated into a summary table and posted in the classroom. (213-9)
- On index cards, students could record information about examples of chemicals found in households, automotive, painting, and/or pesticides/herbicides. Include: sources, precautions, storage, disposal, incompatibility, and the appropriate WHMIS or Consumer Product Symbol. (213-9)

Journal

- Students could reflect on the types of chemicals stored in their houses. Are these chemicals stored properly? Are there any changes that should be made in the storage? Are they familiar with the cleanup and disposal methods associated with each chemical? (213-9)

Performance

- Teachers could list the names of a variety of substances that contain harmful chemicals (e.g. window cleaner, antifreeze, battery acid, propane, etc.) on index cards and an accident scenario (e.g. swallow antifreeze). Students could draw a card from a hat. Given the scenario and substance, they would have to determine the proper first aid treatment using the various MSD sheets available. Students would then record the appropriate response to the accident on the reverse of the card and report back to class. (213-9)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 72-75

TR: 2.9-2.11

BLM (2.16) 2.4

Chemistry Around You *(continued)*

Outcomes

Students will be expected to

- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials (213-9) **Cont'd**
  - use a MSDS sheet to recognize the hazards associated with consumer products
  - identify the nine categories on a MSDS sheet
  - describe when WHMIS information or MSDS information would be best used
  - list several environmentally friendly alternatives to consumer products. Include examples from:
    - (i) household cleaners
    - (ii) pesticides
  - relate home, workplace and environmental attitudes to the information found on a MSDS
  - state the government regulations regarding employers, employees and MSDS
  - describe how environmental attitudes and practices have changed in Newfoundland and Labrador

Elaborations—Strategies for Learning and Teaching

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 213-9 and its delineations. The STSE component, *Staying Safe on the Job: How to Use Material Safety Data Sheets,* can be found in Appendix A.

Chemistry Around You *(continued)*

Suggested Assessment Strategies

Performance

- Students could create and conduct a survey of members of their community (teachers, students, family, neighbours, etc.) to determine views on environmentally friendly products and how many people use these products in their daily lives. Is there a correlation? Do the views of people relate to their practice? Students could report their findings to the class. (117-1, 213-5, 213-9)

Paper and Pencil

- Students could create a table that compares the advantages and disadvantages of "environmentally friendly" consumer products. (117-1, 213-9, 213-5)

Journal

- Students could consider the impact their daily use (or their family's) of various household or lawn care products has on the environment. They could list the changes they would like to make in their use of these chemicals in order to be more environmentally friendly. (213-9)
- Students could reflect on whether or not it would be possible to avoid encountering hazardous chemicals during their daily activities. (213-9)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 72-75

TR: 2.9-2.11

BLM: 2.11 (2-4)

SRL: 102-107

Core STSE #2: *Staying Safe on the Job: How to Use Material Safety Data Sheets,* **Appendix A**

Classification of Matter

Outcomes

Students will be expected to

- construct a classification system for matter (210-1)
  - define and distinguish between the following terms:
    - (i) pure substances and mixtures
    - (ii) compounds and elements
    - (iii) atoms and molecules
    - (iv) solutions (homogeneous mixtures) and heterogeneous mixtures

Elaborations—Strategies for Learning and Teaching

The study of all matter covers a wide range of substances with many different properties. (There is a large difference between oxygen gas and a milkshake, both examples of matter.) To help simplify the study of matter, chemists attempt to organize matter based on its composition and properties. Teachers should note that there is no one, accepted classification system, although there are a couple of more common systems. Teachers could introduce this topic by asking students to develop their own classification systems for common household substances studied earlier.

Students will have studied about atoms at the intermediate level; however, teachers may need to review the definition of atoms as the smallest particle of matter that cannot be broken down into simpler substances. Atoms will be discussed in more detail in a later section.

A common student misconception is to consider compounds as mixtures. The main difference, for the purposes of this course, is that the components of a mixture do not join together to create a different substance. The components of a mixture can be separated using simple techniques (based on physical properties). For example, a mixture of sugar and sand can be separated by adding it to water (dissolve the sugar), then filtering to separate the dissolved sugar from the sand. Finally, evaporate the water to get the sugar. In a mixture, the components are sometimes visible (may require magnifying glass). In compounds, two or more atoms combine by "joining" together in a fixed ratio (e.g. 1:1, 2:1, 2:3, etc.), and can not be separated by simple laboratory techniques (based on physical properties). Teachers could use molecular model kits to ask students to construct models of various compounds. Teachers could ask students to complete the Extension Activity which is described on page 2-14 of the TR.

Students may have difficulty accepting that a substance like tap water or "pure spring water" would be classified as a mixture, i.e. they are not "pure" in a chemical sense. All water (with the exception of distilled water) contains dissolved minerals, therefore, it would be best classified as a solution (i.e. it is a homogeneous mixture). The same is true of many other "pure" substances such as air, foods (e.g. vegetable oil), and soaps. Pure, in the consumer sense, is used to denote the absence of impurities (it may suggest a level of safety for human use) or to indicate that it is the same throughout. For example, a block of butter will contain the same chemicals in the top, middle, and bottom of the block; only "butter" is present. Some examples of mixtures suggested by students as "pure" will actually be mixtures. For example, soap, soft drinks, mayonnaise, and wood.

Classification of Matter

Suggested Assessment Strategies

Performance

- Teachers could develop a "quiz-quiz-trade" activity using the 8 terms listed under 210-1. Each student could be assigned a term and given an index card. They then write the term on one side and the definition on the other. Each student then takes his/her card and walks around the classroom until a signal is given (e.g. play music he/she walk; stop music, he/she stops). When they stop, they pair with the person closest to them. The first student "quizzes" the second by either giving the definition and asking his/her partner to provide the term or vice versa. The second student then does the same with his/her card. If a student does not know the answer, his/her partner tells him/her. They then "trade" cards. When the music starts he/she walk, when it stops he/she stops and pair with a different student. Each quizzes his/her partner, then exchange cards, and move along when the signal starts. This can continue for a set number of minutes or until each student has formed 5 "partnerships". (210-1, 215-6)

Observation

- Given a prepared mixture in a sealed container (e.g. sugar and salt, sand and charcoal, baking soda and flour, salt and pepper, gravel, etc.) using only visual cues, students would identify whether the mixture is homogeneous or heterogeneous. (210-1)

Paper and Pencil

- Students could be provided with a table which lists a number of common substances in one column (e.g. diamond, copper in "copper wire", salt water, bread, etc.). In the corresponding column students are to indicate to which group the substance belongs (i.e. which of the 8 terms matches the substance). Depending upon the list created, some substances may fit several groups which shows the connectedness between the terms (e.g. copper is an atom, an element, and a pure substance). (210-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 76-77

TR: 2.12 - 2.14

SRL: 108-112

BLM: 2.2a 92-5)

Classification of Matter *(continued)*

Outcomes

Students will be expected to

- compile and display information in a flow chart (214-3)
  - graphically depict the classification of matter in an organizational chart
- identify properties that allow substances to be distinguished from each other (300-10)
  - distinguish between chemical and physical properties
  - distinguish between chemical and physical changes

Elaborations—Strategies for Learning and Teaching

Teachers could use BLM 2.2a (or a simplified version) to summarize this information or to review. Teachers could use the activity on pages 108 - 112 of the SRL to review this and the following outcomes. If students completed the household product classification activity, they could draw diagrams representing their classification system.

A physical property is an observable feature of a substance (without making any change in the composition of the substance). For example, observing the color of a substance does not change the substance. A chemical property is only observable as the substance undergoes a change in composition. For example, whether or not a substance has the chemical property of being able to burn is only observable if the substance is actually displaying this property (i.e., it is burning).

Students have studied chemical and physical changes in previous grades (elementary and intermediate). When determining if a change is physical or chemical, students should focus on whether the substance "changes" composition. For example, "ice melts". The substance is water when it was solid, it was still water after it melted, therefore, "ice melts" is a physical change. On the other hand, "iron rusts". The iron was dark in color, bendable, hard, conducted electricity before it rusted. After rusting, it is orange, crumbles and does not conduct electricity. The physical properties have changed, therefore, composition of the iron must have changed - this is a chemical change.

Teachers could ask students to provide examples of chemical and physical changes. These could be tabulated in a chart on the board. Examples that may be raised are:

Physical Changes	Chemical Changes
crumbling, bending, condensing, melting, boiling, breaking, tearing, solubility (dissolve or not)	burning, rusting, cooking of foods, rotting of foods, digestion, explosion

The changes listed above are descriptors that a teacher could use when developing specific examples of chemical and physical changes that would be categorized on the board. For example, a cookie crumbling, iron rusting, egg frying, etc.

Classification of Matter *(continued)*

Suggested Assessment Strategies

Performance

- Students could create a rap, song, or poem that describes the characteristics of the matter classification chart. This could include how the various characteristics are related. (114-8, 214-3)
- Students could create a mnemonic to help them remember the terms associated with the classification of matter. (214-3)
- Students could create a rap, song, or poem that describes the characteristics of physical and chemical changes (and/or physical and chemical properties) and explains the differences between each. (117-5, 300-10)

Presentation

- Small groups of students are provided with a sheet of paper, coloured yarn/string, and masking tape. The group is then assigned one of the terms representing the classification of matter (e.g. mixture, element, etc.). On the paper, the group defines the term and provides several examples of substances that fit this term (classification). Each group will contribute their term to a class chart which will display the classification of matter. This can be done by taping their paper to a large surface (e.g. wall) and connecting the terms with the string/yarn. (214-3, 215-6)
- Students could create a collage of physical properties and physical changes (and/or chemical properties and chemical changes) which they will present to the class or display. (117-5, 213-5, 300-10)

Portfolio

- Students could be required to create a graphical depiction of the matter classification system to be included in their portfolio. (214-3)
- Students could create a product for entry into their portfolio. This entry is to be comprised of text and visual images obtained from magazines, newspapers, Internet, etc. The entry will clearly distinguish between the physical and chemical properties and changes. (117-5, 213-5, 300-10)

Paper and Pencil

- Students could create a table that lists several examples of chemical and physical changes. (300-10)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 76-77

TR: 2.12-2.14

BLM: (2.2a) 2-5

SRL: 108-112

Classification of Matter *(continued)*

Outcomes

Students will be expected to

- identify properties that allow substances to be distinguished from each other (300-10) **Cont'd**
  - list four pieces of evidence of chemical change. Include:
    - (i) color change
    - (ii) solid (precipitate) formed
    - (iii) bubbling (gas production)
    - (iv) energy change (e.g. light, electricity, heat)

Elaborations—Strategies for Learning and Teaching

When a substance undergoes a physical change, the makeup of the substance has not changed. For example; when a piece of iron bar is bent, it is still a metal with the same properties it had before it was bent. When a substance undergoes a chemical change the makeup of the substance is changed and a new substance is formed. For example, recall when iron rusts a new substance is formed and the new substance does not have any of the properties of the original iron (i.e. the rust will no longer bend, it is not shiny, does not conduct electricity, etc.). The rust is a completely new substance (composed of iron and oxygen) with physical and chemical properties of its own and is nothing like the two chemicals of which it is composed. [Another example of chemical change is the ripening and subsequent rotting of a banana or any fruit. As the banana ripens the starch turns into sugars and tastes very differently. Teachers could bring a ripe and unripe banana and ask the students to taste the difference which has occurred through the chemical changes that take place during ripening. (Check for food allergies first!)] Often a chemical change is one-directional; once the change occurs it can not be reversed (or at least is difficult). In some instances a physical change may occur that can not be easily reversed (e.g., a crushed pop can not be easily returned to its original form; it must be melted and remoulded in order to be made into a new pop can).

Figure 5, page 77 of the textbook, is a simplified version of evidence of chemical changes. "Burning" is only one example of a chemical change that involves energy change (a thermal change). Another example could include a battery discharging (electrical energy).

Teachers could use BLM 2.2b to review this section.

Classification of Matter *(continued)*

Suggested Assessment Strategies

Performance

- When given a series of chemical substances (e.g. ionic solutions, metals, acids) students could use a table to record their observations when they mix two together. Based on their observations (e.g. precipitate formed, gas evolved, heat evolved, colour change) they would decide whether a reaction occurred or not. (213-2, 213-5, 300-10)

Interview

- When the teacher mixes two chemical substances together, the student could identify the evidence (if any) of chemical change. (300-10)

Journal

- Students could record the various chemical changes that occur in their daily lives (e.g. food spoilage at home, etc.) and describe the evidence they use to determine that a chemical reaction occurred. (117-5, 300-10)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 76-77

TR: 2.12-2.14

SRL: 108-112

Periodic Table, Atoms, & Ions

Outcomes

Students will be expected to

- use a classification system (210-1)
  - describe the periodic table of elements as a means of organizing elements.
  - identify vertical columns as groups or families which exhibit similar properties
  - identify that elements are arranged in order of increasing number of protons (atomic number) on a periodic table
  - identify metals, nonmetals, and non-reactive gases (Noble gases)

Elaborations—Strategies for Learning and Teaching

Teachers could refer to page 310 of the student textbook for an example of a periodic table. A more simplified periodic table, which is to be used in future sections of this unit (e.g. for naming, balancing equations, etc.) is to be found in the appendices of this guide. It is important for students to realize that the shape and arrangement of the periodic table is determined by the properties of the elements (similar elements were placed in columns. SEE STSE).

Teachers could ask students to use the periodic table on page 310 to introduce them to the concept that there are many different types of elements and that they are organized in a special table. In this table all the metallic elements are coloured green. The purple-colored elements are known as metalloids because they have properties of both metals and nonmetals. The elements colored orange and blue are all nonmetals. Hydrogen is shaded yellow because it has unique chemical properties and as such can not be placed with any of the other families of elements.

The blue colored elements are known as the Noble gases because they do not react; i.e. they are chemically stable. The Noble gases are an example of a "family" of elements (found in a vertical column). Each of the vertical columns of the table (families) has similar chemical and physical properties. For example, column 1 has the elements Li, Na, K, Rb, Cs, and Fr. Each of these metals react in similar ways and have similar properties. Similarly the elements in column 17 have similar chemical properties and will react in similar ways.

Each element is given its own unique number called the atomic number. This number is in the top left hand corner of the box. This number corresponds to the number of protons an element has (see later in this guide). For example, iron's atomic number is 26 and it has 26 protons.

The colors of the symbols indicate their state at room temperature. Black are solids, red are gases, and blue are liquids. In general, the solid "staircase" line separates the metals from the nonmetals.

NOTE: each block of the periodic table contains much more information than will be used in this course. Students are only expected to be able to recognize the name, symbol and atomic number (refer to periodic table in Appendix C).

Periodic Table, Atoms, & Ions

Suggested Assessment Strategies

Performance

- Students could create a rap, song, or poem that summarizes the information contained in the periodic table. (210-1)
- As a review or summary activity, each student could create 5 "challenge questions" about the location of elements on the periodic table (e.g. "Which element is a liquid halogen?") Once they create their questions, they then trade their questions with a partner who attempts to answer all of the questions. When completed, the student who created the questions, checks for accuracy. Students should try to make their questions as difficult as possible because any questions their partner can not answer gets added to their overall score (i.e. if they get all five correct and their partner misses 2 their score is 7). Teachers might want to award prizes for the highest score or most interesting/challenging question. (210-1, 215-6)

Portfolio

- When given a blank or simplified periodic table chart, students could write the names of the families in the appropriate columns. (210-1)

Paper and Pencil

- As enrichment, teachers could explain the relevance of the horizontal rows in the periodic table (i.e. the periods). Students could then use this information to predict the number of energy levels various atoms would have. Students could identify the "mystery element" when given the group number and period. (210-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-79

TR: 2.15-2.17

SRL:

BLM: 2.7-2.11

Note: Periodic Table in text at back of book

Periodic Table, Atoms, & Ions *(continued)*

Outcomes

Students will be expected to

- use a classification system (210-1) **Cont'd**
  - distinguish between metals and nonmetals. Include:
    - (i) position on periodic table
    - (ii) physical properties
- describe alchemy and compare the alchemy of early civilizations and the Middle Ages to the practice of chemistry today. (NLS-1)
- explain the roles of evidence, theories, and paradigms in the development of Mendeleev's periodic table of elements (114-2)
- identify new questions and problems that arise from unexpected discoveries in chemistry history (210-16)
- provide examples of how chemistry is an integral part of our lives (117-5)

Elaborations—Strategies for Learning and Teaching

Students could be asked to search through the periodic table and identify as many of the metals with which they are familiar (e.g. iron, copper, gold, etc.). Alternatively, teachers could make a list of common elements (or their symbols) and ask students to search the table and write the corresponding symbols/names. The elements are represented by one or two letter symbols that normally are the first or first two letters of the elements' name. Students should write the symbols of the elements as they appear in the table. ONLY the first letter is ever capitalized. For example; Calcium is written Ca NOT "CA" or "ca".

Teachers could ask students to consider why the letter symbols for many of the elements do not correspond to the element's name (e.g. Iron, number 26, has the symbol Fe). Some elements' symbols are based on their Latin name (e.g. the Latin name for Iron is Ferrum), while others are known by their English name (e.g. Aluminum has the symbol Al). One element has a symbol that is not based on its English or Latin name - Tungsten. Its symbol, W is based on its German name (the country in which it was first isolated). Students could be challenged to find the element that has a symbol not derived from Latin or English names.

Teachers can refer to page 108 and page 110 of the student textbook for the physical properties of metals and nonmetals.

Investigating the physical properties of elements provides an opportunity to demonstrate the properties and/or research interesting facts about the elements. For example, teachers could compare the bending of a piece of copper wire and compare it to bending a carbon rod (a pencil lead is a good source of carbon). Students could research to determine the most ductile element (ability to be drawn into wires) or the element with the highest melting point and so on.

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 210-1, ACC-1, 114-2, 210-16, 117-5 and their delineations. The STSE component, *From Alchemy to Chemistry,* can be found in Appendix A.

Periodic Table, Atoms, & Ions *(continued)*

Suggested Assessment Strategies

Presentation

- In groups, students could use magazines, Internet, etc. to create a collage that shows either the importance of specific metals and/or nonmetals in their daily lives or a collage that demonstrates the specific properties of metals and/or nonmetals. (117-5, 210-1, 215-6)

Portfolio

- Students could create a summary chart of the properties of metals and nonmetals for inclusion in their portfolio. (210-1, 213-5)

Journal

- Students could reflect on the importance of various metals and nonmetals in their daily lives. Which are the most common? Could they go the entire day without encountering metals or nonmetals? (117-5, 210-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-79

TR: 2.15-2.17

BLM: 2.7-2.11

Core STSE #3: *From Alchemy to Chemistry,* **Appendix A**

Periodic Table, Atoms, & Ions *(continued)*

Outcomes

Students will be expected to

- use models in describing the structure and components of atoms and ions (307-14)
  - describe the Bohr model of the atom. Include:
    - (i) location of protons, neutrons, and electrons
    - (ii) the arrangement of electrons for the first 20 elements
  - draw Bohr models for the first 20 elements

Elaborations—Strategies for Learning and Teaching

The Bohr model of the atom is a simplified way of describing the structure of atoms and ions. When drawing Bohr models, the element's symbol is put in the center (this represents the nucleus of the atom) and circles are drawn around it. These circles represent the levels (areas) in which the electrons move around the nucleus of the atom (electrons have a negative charge). The nucleus contains the neutrons and protons (these particles compose the mass of the atom). Neutrons have no charge (neutral) and protons are positively charged. In atoms, the number of electrons and protons are equal (i.e. the atom has no charge). Teachers can refer to Figure 1, page 78 to see examples of the Bohr model of the atom for fluorine (F) and sulfur (S).

At first, students may not realize why they study the Bohr model and how it explains the electron arrangements around atoms. When drawing Bohr models of atoms, students should understand that electrons are placed in the levels in a specific pattern. This pattern determines how atoms form bonds or ions. Once students can predict what ions (or number of bonds) are possible, they are able to predict the formula of compounds (this comes later in the course). For example, when magnesium (Mg) and chlorine (Cl) react they produce $MgCl_2$. This occurs because, based on their electron arrangements, the magnesium atom forms a Mg^{2+} ion, while the chlorine atom forms a Cl^- ion. To make similar predictions, students must first be able to produce the electron arrangements.

The first level (closest to the nucleus) can hold a maximum of 2 electrons, the next level (second circle) can hold a maximum of 8 electrons. The third level (third circle) can also hold a maximum of 8 electrons. Teachers may want to provide students with the following example when teaching how to construct Bohr models. Using sodium:

- First write the symbol of the atom (Na) to represent the nucleus.
- Since Na has atomic number 11, it has 11 protons (positive) and an equal number of electrons (11). Thus we have 11 electrons to arrange in levels.
- The 1st level contains 2. Draw a circle and use two large dots (or lower case "e^-") to represent the electrons. Nine electrons are left to place.

Periodic Table, Atoms, & Ions *(continued)*

Suggested Assessment Strategies

Performance

- Using string/yarn and modelling clay/play dough, students could create physical models of various atoms. These could be attached to poster boards and displayed in the classroom. (215-6, 307-14)

Paper and Pencil

- Students could draw Bohr models of the first 20 elements. (307-14)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-81

TR: 2.15-2.17

BLM: 2.7-2.11

SRL: 114-115

Periodic Table, Atoms, & Ions *(continued)*

Outcomes

Students will be expected to

- use models in describing the structure and components of atoms and ions (307-14) **Cont'd**

Elaborations—Strategies for Learning and Teaching

- Draw another circle to represent the 2nd level. Remember this level can only hold a maximum of 8 electrons. Since we have 9 electrons we will place 8 dots (or e's) in this level and have 1 electron remaining.

- Draw the 3rd level and place the remaining electron here.

- To double check, count the number of electrons you have placed. This number should equal the atomic number of the element. Double check to ensure each level does not contain more than the maximum number of electrons it can hold (e.g. 2, 8, 8).

Teachers should note that Bohr models of the atom only work for the first 20 elements. After this, a more sophisticated model is required to represent atoms and ions.

- define valence level
- recognize the first 3 non-reactive gases as having full valence levels

Teachers should ask students to draw Bohr models for the first 20 elements (for K and Ca students would have to draw a fourth level and place the remaining electrons there). After this exercise, ask students to compare the Bohr models of the first 3 Noble gases with the 17 other elements and ask them what they notice. They should notice that the outermost level (or valence level) has its maximum number of electrons (i.e. the level is "full"). Worksheet 1 (Appendix B) may be used at this point (see appendix). Note that elements 19 and 20 are not on this worksheet. Teachers may want to use these as challenge items.

- define ions as atoms that have gained or lost electrons.
- draw Bohr models of the ions that form from the first 20 atoms

Teachers could refer to Figure 2 on page 78 as they teach this section. Teachers could refer back to the Bohr models the students have drawn previously and their initial description of the Noble gases as non-reactive. Teachers could then draw the relationship to the non-reactive character of these elements to their valence level. Since all other atoms are reactive and Noble gases are not we could ask why this might be so. Using their Bohr models of the first 20 atoms, students should be able to conclude that the other 17 atoms are reactive because their valence levels are not filled (since the valence levels of Noble gases are full, they are not reactive). In fact, when these atoms do react, they do so in order to have an electron configuration that is like their nearest Noble gas, based on atomic number (i.e. the valence level is full).

- recognize that ions have full valence levels

In order to become like their nearest Noble gas, atoms will either lose electrons from their valence level (metals) or gain electrons into their valence level to fill it (nonmetals). This lost or gain of electrons changes an atom into an ion.

Periodic Table, Atoms, & Ions *(continued)*

Suggested Assessment Strategies

Performance

- Using string/yarn and modelling clay/play dough, students could create physical models of various ions. Use different coloured clay/dough to represent electrons gained. The overall charge on the ions should be indicated. These could be attached to poster boards and displayed in the classroom. (215-6, 307-14)

Portfolio

- Students could create a summary table (three columns) that shows the Bohr model for representative atoms and their corresponding ions. The first column will have the name of the element, the second column would have the Bohr model of the atoms, the third column would contain the Bohr model of the corresponding ion. (307-14)

Journal

- Referring back to what they learned about the difference in the valence levels of atoms and ions, students could reflect upon how this relates to the non-reactivity of atoms in the Noble Gas family. (307-14)
- Using the models they have drawn for the first 20 elements, students could then identify the valence level trends that occur between elements within the same family/group. (307-14)
- Referring to the models they have made for the first 20 ions, students could reflect upon the relationship between the elements in a particular group and the charge on the ions in this group (i.e. ions in group 6 all have a 2- charge). (214-5, 307-14)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-81

TR: 2.15-2.17

BLM: 2.7-2.11

SRL: 114-115

Periodic Table, Atoms, & Ions *(continued)*

Outcomes

Students will be expected to

- use models in describing the structure and components of atoms and ions (307-14) **Cont'd**
  - recognize that metals lose electrons to form positive ions
  - recognize that nonmetals gain electrons to form negative ions

Elaborations—Strategies for Learning and Teaching

Using sodium (Na) as an example when we draw the Bohr model we note it has 1 electron in its valence level. This valence level could hold up to 7 more electrons. In order to look like its nearest Noble gas (Neon) it has to have a full valence level. In terms of energy, it is easier to get rid of the single electron instead of bringing another 7 electrons in, Na loses its valence electron and now has 10 electrons just like Neon. Remember that in an atom the number of electrons (negative) equals the number of protons (positive) which cancel each other out given a net charge of zero (i.e., the atom is electrically neutral). Because sodium has lost a negatively charged electron the sodium ion will now have one more proton (11 protons) than it has electrons (10 electrons). As a result one of the protons is not cancelled out and the overall charge on the sodium ion is one positive (1+). To indicate the sodium atom has lost an electron to become an ion with a charge of 1^+ we write the charge in the upper right-hand corner of the symbol (Na^+).

Similarly, Fluorine (see figure 2, page 78) has 7 electrons in its valence level. By gaining one more electron it now looks like the Noble gas Neon. Because it has gained one electron, it now has one more electron (i.e. it has 10 electrons) than it has protons (i.e. fluorine has 9 protons). As a result it has an overall charge of 1^-. We write the symbol for the fluorine ion as $F1^-$. Note, when naming ions metal ions keep the name they have in the periodic table. Nonmetal ions have their endings changed as follows: Nitrogen (Nitride); Oxygen (Oxide); Fluorine (Fluoride); Phosphorous (Phosphide); Chlorine (Chloride); Bromine (Bromide); Iodine (Iodide); Sulfur (Sulfide); Selenium (Selenide); Astatine (Astatide).

Students may ask where the electrons that metallic atoms lose go or from where the nonmetallic atoms get the electrons they need to fill the valence level come from. The transfer of electrons occurs during chemical reactions (which they will do later) where one atom (metallic) gives its electrons to another atom (nonmetallic). The resulting positive and negative ions are attracted to one another and form a chemical bond that holds them together (this is covered in the next section).

Periodic Table, Atoms, & Ions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-81

TR: 2.15-2.17

BLM: 2.7-2.11

SRL: 113-115

Simple Ionic Compounds

Outcomes

Students will be expected to

- use models in describing the structure and components of atoms and ions (307-14) **Cont'd**
- explain the relationship between the energy levels in Bohr's model and the production of a photon (329-3)
  - define photon
  - define the terms "ground state" and "excited state" for atoms
  - describe a photon of light as being produced when an excited electron relaxes back to a lower energy level
- provide examples of how science and technology are an integral part of our lives, using the examples of light bulbs and fireworks (117-5)
- identify new questions and problems that arise from what was learned (210-16)

Elaborations—Strategies for Learning and Teaching

Teachers could use the BLM's 2.3a, b, c, and d to review the content covered in this section. The four main chemical families are listed on BLM 2.3a and 2.3b. Alkali Metals are found in column 1; Alkaline Earth Metals are found in column 2; Halogens are found in column 17; Noble Gases are found in column 18 as referenced on page 310 of the student text. Teachers could now use Worksheet 2 (Appendix B) to ask students to draw Bohr models of the ions that will form from the first 18 elements. Note that elements 19 and 20 are not on this worksheet. Teachers may want to use these as challenge items.

If using Worksheet 2, teachers will note that there are two spaces for drawing Bohr models of hydrogen ions. This relates to the special properties of hydrogen. In particular, as hydrogen has only one valence electron, it is possible that hydrogen atoms give up the single electron to have an empty valence energy level (i.e. become a 1+ ion) or gain one electron to fill the energy level (i.e. become like the noble gas Helium and have an overall charge of 1-). Depending upon the reaction in which it is involved, hydrogen can act like a metal (i.e. lose electrons and become a positive ion) or like a nonmetal (i.e. gain electrons and become negative). Teachers may wish to challenge students to come up with this notion on their own (i.e. that hydrogen can form two types of ions).

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 329-3, 307-14, 117-5, 210-16 and their delineations. The STSE component, *From Light Bulbs to Fireworks,* can be found in Appendix A.

Simple Ionic Compounds

Suggested Assessment Strategies

Performance

- Using Bohr models of a positive and negative ions, students could create a diagram that shows the resulting compound (e.g. Na^+ and Cl^-). Students should include an arrow that shows the direction of electron transfer. (114-8)
- Using string/yarn and modelling clay/play dough students could create physical models of various ionic compounds. Use different coloured clay/dough to represent the electrons of each ion (e.g. Na^+ electrons could be red and Cl^- electrons could be blue). These could be attached to poster boards and displayed in the classroom. (114-8, 214-5, 214-6)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-81

TR: 2.15-2.17

BLM: 2.7-2.11

SRL: 113-115

Core STSE #4: *From Light Bulbs to Fireworks,* **Appendix A**

Outcomes

Students will be expected to

- describe the usefulness of IUPAC scientific nomenclature systems to convey chemical information (114-8)
  - define attractive forces between atoms or ions as bonds
  - describe compounds as substances that form when atoms/ions bond together
  - define ionic compounds as combinations of metal ions (positive) and nonmetal ions (negative)
  - define molecular compounds as combinations of nonmetallic elements
  - distinguish between molecular and ionic compounds

Elaborations—Strategies for Learning and Teaching

This IUPAC system is a universal naming system used by scientists all over the world when they are naming chemical compounds. Chemical compounds are formed during chemical reactions between two or more different types of atoms. A compound often has very different chemical and physical properties than the elements which produced it. This is logical, since a compound is a different chemical species. (This further distinguishes a compound from a mixture - covered earlier.) This naming system ensures that scientists will be able to understand one another even if they speak different languages.

As noted earlier, atoms tend to be less stable than Noble gases. There are two ways in which atoms can become more stable. The first is to either gain or lose electrons as described above. When metallic and a nonmetallic atoms come together they may transfer electrons to become more stable. In doing so, they develop opposite charges and are attracted to one another. This attraction due to different electrical charges (i.e. the attraction between ions) creates a chemical bond between the ions. This bond between ions is called an ionic bond. When two or more ions are held together by an ionic bond, an ionic compound is formed. (Teachers could use the analogy of magnets attracting to opposite poles to convey the idea of a mutual attraction that forms a bond.) In the case of ions and magnets, like charges repel and unlike charges attract.

The second way atoms can become stable (i.e. look like a Noble gas) is to share electrons. This happens between nonmetallic atoms only. Two or more nonmetallic atoms can come together to share their electrons during a chemical reaction. This sharing of electrons creates a bond between the atoms and causes them to stay together. When two or more nonmetallic atoms are joined by a bond, this forms a molecular compound.

In some situations atoms will share electrons with other atoms of the same type in order to become stable. Elements that do this are hydrogen (H_2); nitrogen (N_2); oxygen (O_2); all the halogens (F_2, Cl_2, Br_2, I_2, At_2); phosphorous (P_4); sulphur (S_8). Students will need to know this for when they predict the products of chemical reactions.

Suggested Assessment Strategies

Paper and Pencil

- When given the chemical formula of a substance, students could be required to classify it as ionic or molecular. (114-8)

Performance

- Students could use styrofoam balls to create models of specific polyatomic ions using different coloured balls to represent different atoms. (319-1)
- In pairs, students could compete in a "chemical naming relay". Each group receives the first question (questions can be written out on index cards before hand, e.g. "what is the formula for sodium sulphide?"). The group goes to their home station and answers the question. When they have the correct answer they come up and get another question (incorrect answers have to be corrected before they can go forward). This continues until one group is the "winner" by completing more questions in relay than the others. (Teachers could set a time limit or a number of questions). (215-6, 319-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 78-81

TR: 2.15-2.17

SRL: 113-115

Simple Ionic Compounds *(continued)*

Outcomes

Students will be expected to

- write names and formulae for some common ionic compounds (both binary and complex), using the periodic table, a list of ions, and appropriate nomenclature for metal and nonmetal ions (319-1)
  - define chemical formula
  - given the chemical formula of a simple ionic compound, determine its name using IUPAC rules
  - using the Periodic table determine the chemical formula for simple ionic compounds
  - recognize that ionic compounds have a net charge of zero

Elaborations—Strategies for Learning and Teaching

Students are not expected to memorize these formulae as a data table will be provided. See Appendix C.

While the student textbook is organized to ask students to write chemical formulas prior to naming ionic compounds, teachers may wish to reverse this process. That is, ask students to learn to write names of ionic compounds when provided a chemical formula and then learn how to write chemical formulas when given the name of an ionic compound. This will provide students with the opportunity to become familiar with the names and symbols of ionic compounds prior to having to deal with the mathematics of balancing electrical charges within chemical formulae. This curriculum document is ordered in this fashion.

Instead of providing the definition of the terms at the left in isolation, teachers should present these terms and their associated definitions when they address the naming of the compounds that apply to these definitions.

Teachers should ensure that students are using the simplified periodic table of ions provided in the Appendix. Also, students are not expected to memorize any information contained in the periodic table. When carrying out naming exercises (including on quizzes or tests) students should be provided with data tables that include the required information for naming.

Teachers should refer to page 80 of the student textbook for sample problems and rules for naming simple ionic compounds. Note: these pages **only** cover the rules for simple ionic compounds.

Worksheet 3 (Appendix B) can be used to review this topic.

Teachers could begin this section by using the Bohr model of sodium (Na) and chlorine (Cl) to show how an ionic compound is formed. The extra electron from sodium's valence level would be transferred over to chlorine's valence level. This would result in the formation of a sodium 1+ ion and a chloride 1- ion. As these two ions are in close proximity to one another, the opposite charges attract and an ionic bond forms. The ratio of ions is 1 Na^+ for each Cl^- ion. The 1+ charge cancels out the 1- charge resulting in a compound that has a net charge of zero. Similarly, the sample problems given on pages 79-80 of the student text can be supplemented using Bohr models.

Worksheet 4 (Appendix B) can be used to review formula writing.

Simple Ionic Compounds *(continued)*

Suggested Assessment Strategies

Portfolio

- Given a list of common ionic compounds (e.g. sodium chloride, magnesium chloride, iron oxide, calcium chloride, etc.) students could research the main sources, main uses, and common names. (117-5, 319-1)
- Given a list of formulae for common ionic compounds (e.g. NaCl, $CaCl_2$, etc.) students could research the main sources, main uses, and common names. (117-5, 319-1)

Paper and Pencil

- Given lists of formulae and names for simple ionic compounds, students could match the correct formula with its name. (319-1)
- Given a list of formulae for simple ionic compounds, students could write the corresponding chemical name. (319-1)
- Given lists of names and formulae for simple ionic compounds, students could match the correct formula with its name. (319-1)
- Given a list of chemical names for simple ionic compounds, students could write the corresponding chemical formula. (319-1)

Journal

- Students could reflect upon the need and importance of having a standardized naming system for chemical compounds. (319-1)

Observation

- Students could be randomly provided with an index card that has a specific charge (e.g. 1+, 2+, 3+,1-, 2-, or 3-. Teachers should ensure that the majority of charges are 1+ and 1-). The teacher could choose one or two "positively charged" students and ask them to stand in front of the class. Other students are then asked to volunteer to come up and "neutralize" the positive charges. This can be repeated by having several "negatively charged" students stand in front of the class and then be neutralized. This can continue until either all of the charges are used up (e.g. all students are grouped + and -) or until no more possibilities exist. This can be repeated by starting again and choosing a different charge to start with (e.g. start with a 3+ charge the first time but start with a 1+ and a 2+ charge the second time). (215-6, 319-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 82-83

TR: 218-220

SRL: 116-117

Polyatomic Ionic Compounds

Outcomes

Students will be expected to

- write the names of complex (polyatomic) ionic compounds, using the periodic table, a list of ions, and appropriate nomenclature for metal and nonmetal ions (319-1)
  - define polyatomic ion (complex ion)
  - define polyatomic ionic compounds (complex ionic compounds)
  - given the chemical formula of a polyatomic ionic compound (complex ionic compound) determine its name using IUPAC rules

Elaborations—Strategies for Learning and Teaching

Teachers could use BLM's 2.3 e, f, and g to provide students with opportunity to review and practise both the naming of and writing formulas for simple ionic compounds.

The definition of a polyatomic ion is on page 82 of the ST.

The steps for naming polyatomic compounds can be found on page 83 of the student text. It is important to note that the first thing one should do when naming an ionic compound is to determine if it is a simple ionic compound or a polyatomic ionic compound. A good rule of thumb that students could use is "if there are more than two types of elements present in the compound, then the compound must be polyatomic". For example: $Ca(OH)_2$ has three different types of atoms present (Ca, O, H). Therefore it is polyatomic. $CaCl_2$ has only two types of elements present (Ca and Cl). Therefore it is a simple ionic compound. If brackets are present, then the compound will always be polyatomic.

As another example, consider the formula Na_2SO_4. Many students may want to name this "sodium sulphur oxide". However, this would be incorrect as SO_4^{2-} is a polyatomic ion (sulphate). Once students recognize that this is a polyatomic compound they should use the table of polyatomic ions to find the name of the polyatomic ion. Then to name the compound, write the name of the positive ion and the negative polyatomic ion (sodium sulphate). Remember the name of any ionic compound will only have two parts (the positive ionic part and the negative ionic part). (Note to teachers: this rule does not include hydrates which are not part of this course). Students are not expected to memorize the names or formulae for polyatomic ions. This data table should be provided to students.

Polyatomic Ionic Compounds

Suggested Assessment Strategies

Portfolio

- Given a list of common polyatomic ionic compounds (e.g. sodium hydroxide, magnesium sulphate, sodium bicarbonate, calcium carbonate, etc.) students could research the main sources, main uses, and common names. (117-5, 319-1)

Paper and Pencil

- Given lists of formulae and names for polyatomic ionic compounds, students could match the correct formula with its name. (319-1)
- Given a list of formulae for polyatomic ionic compounds, students could write the corresponding chemical name. (319-1)

Journal

- Students could reflect upon the differences between simple and polyatomic ions and come up with a strategy for distinguishing between them. (319-1)

Performance

- As an extension to the "chemical naming relay", teachers could produce a series of questions that include simple and polyatomic naming exercises with the more difficult questions coming towards the end. (215-6, 319-1)
- Students could work in groups to design a game for naming and/or writing the formula for simple and polyatomic ionic compounds. Students could test their games on other students in the class. (215-6, 319-1)

Portfolio

- Given a list of formulae for common polyatomic ionic compounds (e.g. $NaOH$, $CaCO_3$, etc.), students could research the main sources, main uses, and common names. (117-5, 319-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: p. 82-83

TR: 2.18-2.20

BLM: 2.14

SRL: 116-118

Polyatomic Ionic Compounds *(continued)*

Outcomes

Students will be expected to

- write formulae for complex (polyatomic) ionic compounds, using the periodic table, a list of ions, and appropriate nomenclature for metal and nonmetal ions (319-1) **Cont'd**
  - using the Periodic table and Table of Complex Ions, determine the chemical formula for complex ionic compounds

Elaborations—Strategies for Learning and Teaching

Teachers could use BLM 2.4 (question 2) to provide practice on naming of polyatomic ionic compounds.

Teachers could use Worksheet 5 (Appendix B) at this point.

Teachers should refer to page 82 of the student text for information on this topic. It is important to ensure that students understand that the polyatomic ion acts as if it were a single ionic unit (e.g., a polyatomic ion with a net charge of 2+ behaves the same as Ca^{2+}). A polyatomic ionic compound is a compound that forms between a polyatomic ion and an ion of opposite charge. When writing chemical formulae for polyatomic ionic compounds, if there is more than one of the polyatomic ion is required to balance out the opposite charge, then it is important that brackets be placed around the polyatomic ion. For example in $Ca(OH)_2$ brackets are required around the hydroxide to indicate that 2 hydroxides are present. This formula indicates that one Ca^{2+} ion is combining with two OH^- ions and forms a compound that is electrically neutral. If the brackets are omitted and the formula written $Ca(OH)_2$ than this indicates that one Ca^{2+} combines with one O^{2-} and two H^+ ions. When you add up the charges it is easy to see that the final compound is not electrically neutral. Thus this formula is wrong.

Teachers could use BLM 2.4 (question 1) to provide practice on writing formulae for polyatomic ionic compounds.

Worksheet 6 (Appendix B) can be used to review formula writing. Teachers could then use the worksheet in the SRL (page 118) to review this topic.

Polyatomic Ionic Compounds *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Given lists of names and formulae for simple AND polyatomic ionic compounds, students could match the correct formula with its name. (319-1)
- Given a list of chemical names for polyatomic compounds, students could provide the appropriate formula. (319-1)
- Given a list of chemical names for simple AND polyatomic ionic compounds, students could write the corresponding chemical formula. (319-1)

Presentation

- Students could use magazines, Internet, etc., to create a collage of examples of different chemical reactions. They could then present and explain their collage to the class. (321-1)

Journal

- Students could reflect on the different chemical reactions that occur in their daily lives. (321-1)

Performance

- Given a collection of geometric shapes that represent atoms, students will model what happens in simple composition and simple decomposition reactions. (321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: p. 82-83

TR: 2.18-2.20

BLM: 2.14

SRL: 116-118

Introduction to Chemical Reactions

Outcomes

Students will be expected to

- state a prediction and a hypothesis based on available evidence and background information (212-4)
  - define precipitate
- evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making (212-8)
- interpret patterns and trends in data, and infer relationships among variables (214-5)

Elaborations—Strategies for Learning and Teaching

Worksheet 7 (Appendix B) can be used to provide a complete review of naming and formula writing of this topic.

Students should practise naming on worksheets which mix up simple and polyatomic ionic compounds for naming and chemical formula writing to provide further practice and skill development.

The skills outcomes 212-4, 212-8, 214-5, and other outcomes are accomplished by performing "Testing Ionic Properties". CORE Activity 2.5. Teachers should ensure the term "precipitate" is defined for the class prior to doing this activity (see page 84 of student textbook).

As this is the first CORE activity of the unit, teachers could refer to the relevant sections of the *Skills Handbook* to refresh students on how to conduct investigations, the various equipment they will use, etc. In particular teachers should refer to pages 254-256 to ensure students are familiar with safety procedures to be used in the laboratory. Refer to appropriate MSD Sheets to ensure safe handling and disposal of the chemicals being used.

Teachers could extend this activity by asking students to investigate the differences between hard and soft water; or the problems associated with high levels of iron, lead or sulfur in tap water. Class discussion could focus on what processes municipalities use to help make our drinking water safe. Students could also investigate how water quality changes with the length of time the tap has been running. For example, standing water, depending on the type of plumbing, may contain more dissolved substances than running water.

- represent chemical reactions and the conservation of mass, using symbolic equations (321-1 Part 1)
  - describe a chemical reaction as a rearrangement of atoms or ions

A chemical reaction can only occur if the chemical bonds within the reacting compounds are broken, which allows the atoms or ions to be rearranged. Then new bonds form, producing new compounds. Teachers could use the Lego analogy to describe chemical reactions. Students could consider a house (or some other object) constructed from several different color and size Legos. The house is held together by “bonds” - the connections between the blocks. A chemical reaction occurs when a student uses all the blocks in the house to make another object (keep in mind he/she must use all the blocks). In doing this, old connections are disconnected and new ones are made (i.e., old bonds are broken - new bonds are formed).

Introduction to Chemical Reactions

Suggested Assessment Strategies

- Students could create a mnemonic that helps them remember the correct format for writing chemical equations and then share it with the class. (321-1)

Journal

- Students could describe how they differentiate among simple composition and simple decomposition reactions. (321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 84-85

TR: 2.21-2.23

SRL: 119-123

ST: 86-87

TR: 2.24-2.26

SRL: 122-125

Introduction to Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using symbolic equations (321-1 Part 1) **Cont'd**
  - list several examples of important chemical reactions. Include:
    - (i) rusting of iron
    - (ii) burning of fossil fuels
    - (iii) photosynthesis (carbon dioxide + water → sugar + oxygen)
  - describe the format for writing chemical reactions. Include reactants, products, plus sign, and arrow.
  - define in terms of the chemicals involved five types of chemical reactions. Include:
    - (i) simple composition (synthesis reactions)

Elaborations—Strategies for Learning and Teaching

This analogy could be extended to help explain the conservation of mass (covered later).

While students have learned about chemical and physical changes earlier in this section, teachers should review what constitutes evidence of chemical reactions, the difference between chemical and physical properties, and the difference between chemical and physical changes.

These 3 examples are common chemical reactions. When iron rusts it combines with oxygen from the air to make the compound which we call rust (iron(III) oxide). Fossil fuels such as coal, oil, gasoline, and propane all will react with oxygen, with sufficient temperature, to produce carbon dioxide and water as well as release energy (this energy comes from the breaking of the bonds in the hydrocarbon). Photosynthesis is a chemical reaction that is vital to life on this planet. Through photosynthesis, plants use carbon dioxide from the air and water to make sugar and produce oxygen.

Teachers could ask students to work in groups to research/brainstorm other examples of chemical changes that occur in everyday life.

Teachers should refer to page 86 of the student textbook. Note, the arrow separates the reactants and products and means "produces" or "forms". The reactants are always written first and on the left hand side of the arrow. The products are always written on the right hand side of the arrow. The general format is Reactants → Products. The plus sign (+) is used if there is more than one reactant and then means "reacts with". A plus sign may be on the products side if there is more than one product produced and means "along with". For example, Reactant 1 + Reactant 2 → Product 1 + Product 2. This would be read "reactant 1 reacts with reactant 2 to produce product 1 along with product 2".

Teachers should ensure students understand that the products of a chemical reaction can only contain elements (atoms or ions) that originally existed in the reactants. The difference is that the atoms/ions are arranged in a different order in the products. For example, Carbon will NOT be found in the products of a chemical reaction if the only reactants are Sodium and Chlorine.

Teachers should refer to the student text pages 86-87 for more detailed information.

In synthesis reactions (simple composition) two elements react to form a compound. Note: it is the only type of reaction that produces a single compound.

Introduction to Chemical Reactions *(continued)*

Suggested Assessment Strategies

Performance

- Given a collection of geometric shapes that represent atoms/ions, students will model what happens in single replacement and double replacement reactions. (321-1)
- Students could participate in a "quiz-quiz-trade" where various examples of chemical reactions are written on one side of an index card and the reaction type is on the other. They would quiz their partner on the type of reaction the example represents. (215-6, 321-1)
- Each student collects an index card with an example of a chemical reaction written on it, from a collection at the teacher's desk. Each type of reaction is posted on the wall at five different places around the room. When signalled, students then move to the place that identifies the type of reaction their example represents. In each of these small groups, the students compare the reactions they have and justify or explain why their reaction fits this group. When signalled, the students deposit their cards as instructed and pick another card from the collection at the teacher's desk and repeat the activity. (215-6, 321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 86-87

TR: 2.24-2.26

BLM: 2.15

SRL: 124-125

Introduction to Chemical Reactions *(continued)*

Outcomes

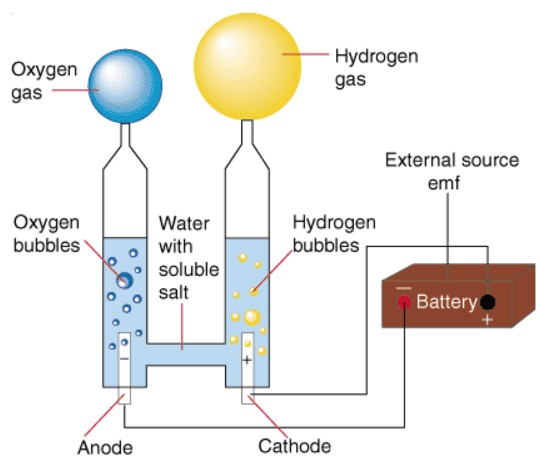
Students will be expected to

- represent chemical reactions and the conservation of mass, using symbolic equations (321-1 Part 1) **Cont'd**
  - (ii) simple decomposition (decomposition reactions)
  - (iii) single displacement (single replacement)
  - (iv) double displacement (double replacement)

Elaborations—Strategies for Learning and Teaching

Decomposition reactions are the opposite of synthesis reactions. In a decomposition reaction, a compound is broken down into its constituent elements. Normally some form of energy is required for this reaction to proceed (e.g. heat, electricity, etc.). Note, decomposition reactions (simple decomposition) are the only type of reactions that has only one reactant.

A decomposition reaction that could be demonstrated is the decomposition of water using the electrolysis of water apparatus.



In single displacement reactions, an element reacts with a compound to produce a different element and a new compound (i.e. the atoms are rearranged). Teachers could use the analogy of a couple being broken up by another person (e.g., John and Mary are going out together. Mary breaks up with John to date Harry. The three people have been "rearranged").

In double displacement reactions, two compounds react to produce two products. In this course, this will only involve ionic compounds. When teaching this concept, teachers could use the analogy of "changing dance partners". For example, consider the reaction AB + CD $\rightarrow$ AD + CB. "A" and "C" are the positive ions (male dancers) that change partners and pair up with the other negative ions (female dancers "B" and "D"). During the dance, imagine the partners switching.

Introduction to Chemical Reactions *(continued)*

Suggested Assessment Strategies

Presentation

- Students could create a rap, song, or poem that helps them differentiate between the 5 types of reactions. They would present this to the class. (215-6, 321-1)

Paper and Pencil

- Working in pairs, students predict the products that will form when given a list of various simple composition and simple decomposition reactions in which only the reactants are indicated. (321-1)

Portfolio

- Students will create a summary chart that will help them identify these two types of reactions. (321-1)

Performance

- Working in small groups, students plan and present a demonstration of what happens in a single replacement reaction (e.g. they can use the analogy of dating, dancing, etc.). After the presentation, the rest of the class discusses whether or not the demonstration is correct and if not, they help correct it. (215-6, 321-1)
- Students could engage in a "quiz-quiz-trade" activity using index cards with both word and formula examples of simple composition, simple decomposition, and single replacement reactions written on one side (reactants only). On the other side is the complete reaction written in word format and chemical formula format. When they pair, the first student asks the other to complete either the word equation or chemical formula equation (i.e. predict the products). If the student can not predict the products, the other student shares the answer with him/her. (215-6,321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 86-87

TR: 2.24-2.26

BLM: 2.15

SRL: 124-125

Introduction to Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using symbolic equations (321-1 Part 1) **Cont'd**
  - (v) combustion

Elaborations—Strategies for Learning and Teaching

In combustion reactions, a hydrocarbon (i.e. a compound that only contains Carbon and Hydrogen atoms) reacts with oxygen (written O_2) to produce carbon dioxide and water. This is always the case. This reaction requires an initial input of energy to get it started (e.g. heat) but produces a lot of energy (e.g., heat and light) as the bonds between the hydrogen and carbon atoms are broken. The products form as carbon atoms react with oxygen in the air (CO_2) and hydrogen atoms react with oxygen in the air (H_2O). Refer back to the chemical bonding section to review why oxygen is written O_2 (and not just O).

Teachers could use BLM 2.6 Part A to review this topic. Teachers could use the "dating analogy" throughout the chemical reaction explanation. For example, Synthesis: two people come together to become a couple; Decomposition: a couple decides to split up and become singles again; Single displacement: as above; Double displacement: two couples break up and begin dating the opposite members.

Worksheet 8 (Appendix B) can be used to review this section.

- given reactants and the reaction type, predict the products of chemical reactions using word equations and chemical symbol equations. Include:
  - (i) simple composition (synthesis reactions)
  - (ii) simple decomposition (decomposition reactions)

At this point, students are not expected to balance the chemical reactions. This will be covered in a later section. With synthesis reactions, you will always have two elements: one will be a metal; the other will be a nonmetal. Since there will only be only one product, this product must be an ionic compound. From our naming rules (see above) the product will be written with the metal name first and the nonmetal name with an "ide" ending. For example, in the synthesis reaction between magnesium and oxygen, the product will be magnesium oxide.

For decomposition reactions, the products will always be the elements that were originally present in the reactant. For example, sodium chloride will decompose to produce sodium and chlorine (sodium chloride $\rightarrow$ sodium + chlorine or $NaCl \rightarrow Na + Cl_2$) Refer to previous discussion of why chlorine forms Cl_2. Remember to provide data table when students are predicting products of chemical reactions. Also, when metals are involved in chemical reactions, their symbol is written just as it is on the periodic table.

Introduction to Chemical Reactions *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Working in pairs, students predict the products that will form when given a list of single replacement reactions in which only the reactants are indicated. (321-1)

Portfolio

- Students will create a summary chart that will help them identify this type of reaction from others. (321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 86-87

TR: 2.24-2.26

BLM: 2.15

SRL: 124-125

Introduction to Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using symbolic equations (321-1 Part 1) **Cont'd**
  - (iii) single displacement

Elaborations—Strategies for Learning and Teaching

In single displacement reactions, we already know that there is an element reacting with a compound to produce another element and a different compound (i.e. there is a "switching" process). Students should be directed to predict what type of ion the element will become. For example, in a reaction between LiCl and Na, the question arises: "What ion in LiCl will Na replace?" To answer this a student requires two pieces of information: 1. LiCl is composed of Li^+ and Cl^-, AND 2. Na will become Na^+. Since Na^+ and Li^+ are both positive ions, the Na^+ will "replace" the Li^+ to produce NaCl. Li is "left over" and the following reaction can be written:

$$LiCl + Na \rightarrow NaCl + Li$$

In this example, the positive ion in the compound is being displaced. The other possible scenario involves the negative ion in the compound being displaced. For example, in the reaction between Cl_2 and HBr, the Cl^- ion will replace the Br^- and following reaction occurs:

$$Cl_2 + HBr \rightarrow Br_2 + HCl$$

Teachers could use an analogy to teach this concept: Na is a single male and LiCl is a boy/girl couple. The single male (Na) causes the couple to break up and starts going out with Cl (the female). As a result they from a new couple while Li (the other male) is left on his own. A similar situation occurs for the second example except that chlorine is the female that breaks up the couple (HBr). NOTE: when ionic compounds form, metals do not join with other metals (similar charges repel), and nonmetals do not join with other nonmetals (similar charges repel). Thus, NaLi and BrCl would NOT be correct products.

Teachers could use BLM 2.6 Part B as a review. (Omit #3, #5, and #7.)

Worksheet 9 and Worksheet 10 (Appendix B) can be used to provide additional practice on predicting the products of chemical reactions. Note, students are not expected to balance these equations at this time.

- (iv) double displacement
- (v) combustion

Double replacement and combustion reactions are OPTIONAL topics. Teachers interested in challenging their students with these reactions should refer to the Science 1206 text book for background information.

Introduction to Chemical Reactions *(continued)*

Suggested Assessment Strategies

Performance

- Students could engage in a "quiz-quiz-trade" activity using index cards with a chemical formula and a coefficient (e.g. 3 H_2O) written on one side. On the other side is the number of each type of atoms represented (e.g. 6 H and 3 O). When they pair, the first student asks the other to indicate the number of each type of atom present. If the student does not get the correct answer, the other student shares the answer with him/her. (215-6, 321-1)

Observation

- Pairs of students are presented with a chemical formula and a coefficient (e.g. 3 H_2O) and predict the number of each type of atom present. Using a molecular model kit, they then construct the molecules (i.e. 3 water molecules) and confirm the number of atoms present. (215-6, 321-1)

Presentation

- Working in pairs, students construct models (e.g. using a molecular model kit, different geometric shapes, different coloured paper, Styrofoam balls, etc.) of different chemical reactions. After they complete the model, they share their solution with the class. If the class notices errors or omissions, they collaborate to complete the model. (215-6, 321-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 88-89

TR: 2.27-2.29

BLM: 2.16

SRL: 126-129

Introduction to Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- use instruments effectively and accurately for collecting data (213-3)
- compile and organize data; using appropriate formats facilitate interpretation of the data (213-5)
- explain how data support or refute the Law of Conservation of Mass (214-12)
  - state the law of conservation of mass

Elaborations—Strategies for Learning and Teaching

The skills outcomes 213-3, 213-5, 214-12, and others are accomplished by performing *"Measuring Masses in Chemical Changes".* CORE Activity 2.7.

Note to teachers: this activity uses iron (III) chloride solution. The "III" indicates the iron as a 3+ charge. Iron, and several other elements in the periodic table (mainly found in columns 3 to 12, also known as the Group B elements, on the periodic table, page 310). Students will not have to name or write formulae for compounds like this.

Teachers should conduct the same safety preparations as per the previous activity.

The law of conservation of mass states that the mass of the products will equal the mass of the original reactant materials. It also means that matter can not be created or destroyed. Teachers could debrief this activity by referencing this law.

Teachers could use BLM 2.7 for students to record their observations. This data can then be transferred to the table on page 126 of the SRL for further analysis and conclusions.

Preparation of Solutions:

For a 1 litre solution of iron (III) chloride (0.01 M concentration), add approximately 1.62 g of solid iron (III) chloride ($FeCl_3$) to 1 litre of distilled (deionized) water. Stir and set aside for the experiment.

For a 1 litre solution of sodium hydroxide (0.01 M concentration), add approximately 0.40 g of solid sodium hydroxide (NaOH) to 1 litre of distilled (deionized) water. Stir and set aside for the experiment.

Note: Measurements do not need to be exact as long as they are close. Teachers should wear protective equipment when preparing solutions (i.e. gloves, goggles, lab coat, etc.).

Introduction to Chemical Reactions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 88-89

TR: 2.27-2.29

SRL: 126-134

Balancing Chemical Reactions

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using balanced symbolic equations (321-1 Part 2)
  - calculate the number of each type of atom represented by a chemical formula

Elaborations—Strategies for Learning and Teaching

In order to successfully balance chemical reactions, it is important for students to be able to count the number of atoms represented by a chemical formula. In the formula CaO there is 1 calcium atom and 1 oxygen atom. In the formula H_2O there are 2 hydrogen atoms and 1 oxygen atom. In the formula $Mg_3(PO_4)_2$ there are 3 magnesium atoms, 2 phosphorous atoms, and 8 oxygen atoms (the brackets indicate there are 2 phosphate polyatomic ions involved and thus everything inside the brackets is multiplied by the number outside; in this case it is 2).

When the number (coefficient) is placed in front of a chemical formula, the number of atoms represented by the formula is multiplied by this number. For example 3 H_2O means that there are 3 units of water. This means there are 6 hydrogen atoms (3 X 2) and 3 oxygen atoms (3 X 1). 2 $Mg_3(PO_4)_2$ means there are 2 units of magnesium phosphate present. This means there are 6 magnesium atoms (2X3), 4 phosphorous atoms (2X2), 16 oxygen atoms (2X8).

Teachers could use BLM 2.8a and 2.8b to review these concepts. Worksheet 11 (Appendix B) can be used for further practice.

Balancing Chemical Reactions

Suggested Assessment Strategies

Journal

- Using their own words, students could write the steps they use to calculate the number of atoms represented by a chemical formula with a coefficient.

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 90-91

BLM: 2.17-2.18

SRL: 126-134

Balancing Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using balanced symbolic equations (321-1 Part 2) **Cont'd**
  - write and balance a variety of chemical reactions. Include:
    (i) simple composition (synthesis reactions)
    (ii) simple decomposition (decomposition reactions)
    (iii) single displacement

Elaborations—Strategies for Learning and Teaching

Chemical reactions can be balanced because of the Law of Conservation of Mass. The objective of a balanced chemical equation is to show that there are equal numbers of each type of atom on both the reactants and products side.

Teachers should ensure that students understand that the chemical formula of a compound can not be changed when they are trying to balance the number of atoms on each side of the arrow. The only thing they can do is put a number/coefficient in front of a chemical formula. Students will need to be proficient with being able to identify the number of atoms represented by a chemical formula (see above).

Teachers could use the Extension Activity 2.3 (page 130 of SRL) to supplement the diagrams of Figures 1, 2, and 3 on page 90 of student text. Teachers should provide several examples of balancing equations using physical models (e.g. colored chips, candies, or molecular models) to represent the substances involved in the reaction prior to asking students to attempt to balance chemical equations. For example, balancing the reaction between Al and O_2 to produce Al_2O_3

($4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$) can be demonstrated on an overhead projector using different shaped objects. For example triangles could represent Al and squares could represent O atoms (i.e. 2 squares = O_2). Note to teachers: you will need 8 triangles and 12 squares to represent $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$. Another way of demonstrating this is to start with 4 triangles (4 Al) and 6 squares (set up as 3 O_2). Move the pieces around to form two groups of "2 triangles and 3 squares" (2 Al_2O_3).

Prior to asking students to write balanced chemical reactions on paper (e.g. worksheet), teachers could ask students to create a series of balanced chemical reactions using physical models. For example, algebra tiles can be used to represent specific atoms. Groups or pairs of students could be provided with a set of tiles and several reactions to create the physical model. After they have created the physical model (i.e. as for the example above), the students can then create the more abstract representation of the reaction (i.e. write the chemical formulae and indicate the required coefficients required to balance the equation). This activity can proceed from giving the students the complete balanced chemical equation, then the unbalanced equation (showing reactants and products), then to providing them with only the formulae of the reactants (i.e. they would have to predict the products first and then create the physical model).

Balancing Chemical Reactions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

BLM: 2.17-2.18

Balancing Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using balanced symbolic equations (321-1 Part 2) **Cont'd**
  - (iv) combustion
  - (v) double displacement
- identify new questions and problems that arise from what was learned, such as the issues behind obtaining hydrogen gas (a possible fuel) from water (210-16)
- identify and describe science and technology-based careers related to the study of chemistry, namely thermite welder or underwater welder. (117-1)

Elaborations—Strategies for Learning and Teaching

The balancing of double replacement and combustion reactions is OPTIONAL.

Teachers could use BLM 2.8c to ask students to practise balancing chemical equations. Teachers may ask students to rewrite H_2O as HOH to allow students to balance OH separately. In part B of this sheet, teachers will have to inform students that the iron (III) is Fe^{3+}. Also, question 3 is optional as it is a double displacement reaction.

Worksheets 12 and 13 (Appendix B) can be used to provide extra practice with balancing chemical equations. Teachers can use Appendix B, "Predicting Products Notes" as either the basis of teaching this section or as a review to combine the concepts of recognizing reaction types, predicting products, and balancing chemical reactions. Algebra tiles could be used with these notes. Worksheet 14 (Appendix B) provides extra practice and review on these concepts/skills.

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 321-1 Part 1, 321-1 Part 2, 210-16 and their delineations. The STSE component, *Reactions in the Real World,* can be found in Appendix A.

Balancing Chemical Reactions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 88-91

TR: 2.17-2.32

BLM: 2.28

SRL: 126-134

Appendix B

Core STSE #5: *Reactions in the Real World,* **Appendix A**

Controlling Chemical Reactions

Outcomes

Students will be expected to

- apply and assess theoretical models for interpreting chemical reaction rates. (214-6)
  - define chemical reaction rate
  - describe the conditions that must be met for a chemical reaction to occur (collision model). Include:
    (i) collision of molecules
    (ii) minimum energy
  - list the factors that affect reaction rate. Include:
    (i) temperature
    (ii) concentration
    (iii) surface area
    (iv) catalyst or inhibitor

Elaborations—Strategies for Learning and Teaching

Chemical reaction rate refers to the speed at which a chemical reaction occurs (i.e. how fast the reactants are consumed and products are formed).

Students should have covered this topic in their grade 9 science program (kinetic molecular theory). In order for a reaction to occur, two requirements need to be met. These are the reactants must come in contact with each other (collide) and secondly, they must hit each other with a minimum amount of energy to cause the bonds to break. In reactions between some materials, the amount of energy required to cause a reaction is very small (e.g., the formation of rust when iron reacts with oxygen; it occurs even at cold temperatures and takes a long time). In other reactions the energy required to start the reaction is very high (e.g. burning a piece of wood; it requires a high temperature for this reaction to start).

The speed at which a chemical reaction occurs can be controlled by these 4 factors. Generally increasing temperature will increase the rate at which a reaction occurs (i.e. it will go faster); increasing the concentration of the reactants (the amount present) will increase the reaction rate; increasing the surface area (i.e. grinding a solid reactant into smaller pieces or into dust) will speed up a reaction's rate; adding a catalyst (a chemical that speeds up a reaction without being used up itself) will speed up a reaction and adding an inhibitor chemical will slow the reaction down. (Many of the chemicals added to processed foods are inhibitors and slow down the chemical reactions that cause food to spoil).

Controlling Chemical Reactions

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 92-98

TR: 2.33-2.37

BLM: 2.20-2.22

SRL: 135-144

Controlling Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- apply and assess theoretical models for interpreting chemical reaction rates. (214-6) **Cont'd**
  - using the collision model, explain the effects of the following on reaction rate:
    - (i) increasing or decreasing the temperature of reactants
    - (ii) increasing or decreasing the concentration of reactants
    - (iii) increasing or decreasing the surface area of reactants
    - (iv) adding a catalyst or an inhibitor
- design an experiment identifying and controlling major variables (212-3)
- select and use apparatus and materials safely (213-8)
- construct and test a prototype of a system and troubleshoot problems as they arise (214-14)

Elaborations—Strategies for Learning and Teaching

Teachers could use the following examples/demonstrations to help clarify these concepts:

- Food left out on a hot day will spoil very quickly (increasing temperature).

- Prepare two 100 mL samples of vinegar. The first is pure vinegar. The second is 25 mL of vinegar topped up to 100 mL with water. To each add ½ teaspoon of baking soda. Observe the difference in the rate of reaction. The pure vinegar sample will react more quickly. This is because there is a greater concentration of vinegar to react with the baking soda.

- Cutting food up into small pieces will cause it to cook faster (cooking food is a series of chemical reactions). For example, cooking whole potatoes takes longer than chopping the potatoes into smaller pieces first. Cutting the potato into smaller pieces increases the surface area that comes into contact with the hot water.

- Hydrogen peroxide (H_2O_2) will automatically decompose into water and oxygen gas (this is evidenced by the bubbles that will come off when a sample is placed in an open beaker). Adding a pinch of MnO_2 (manganese (IV) oxide, also known as manganese dioxide) will cause the oxygen to be produced so quickly it will foam up. The manganese dioxide is not consumed and will remain in the beaker after the reaction stops (catalyst).

- More examples are available in the TR pages 2-34.

The skills outcomes 212-3, 213-8, 214-14 and others are accomplished by performing *"Blast Off!".* CORE Activity 2.10.

In this activity, students could work in groups. The competition could be to see which team can make a solution that pops the lid off the fastest. The teacher could set up a two jugs of water, one jug with ice and the other with warmer water. The teacher could also place a pestle and a mortar (see page 263) on a counter for groups to use. Students will have to use what they have learned to prepare their solution. Students should record how they prepared their solution. No other guidelines need to be given except what is in the student text.

The group that crushes its antacid tablets with the pestle and mortar (increases surface area) and uses the warmer water (increases temperature) will have the right idea. The amount of water used in the canister will also be a factor that will affect the reaction rate (concentration). Afterwards, the teacher and students could have a class discussion about why one group's lid "blasted off" more quickly than some of the others.

Controlling Chemical Reactions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 92-98

TR: 2.33-2.37

BLM: 2.20-2.21

BLM: 2.29

SRL: 135-144

Controlling Chemical Reactions *(continued)*

Outcomes

Students will be expected to

- identify and describe science- and technology-based careers related to the study of chemistry (117-1)

Elaborations—Strategies for Learning and Teaching

Many of the safety precautions associated with the various chemicals that are used on job sites are related to their chemical properties (e.g. solvents used in roofing jobs, cleaning materials in garages, etc.). Many of the processes that occur in the food industry require knowledge of chemistry (e.g. salting fish, temperature regulation in the crab industry, etc.). Many chemical processes are used in water and sewage treatment facilities as well as the maintenance of swimming pools. The people working in these areas need a good understanding of the chemistry that goes on in their workplace.

Teachers could ask students to investigate workplaces in which knowledge of chemistry would be necessary or beneficial, where workers handle dangerous chemicals or use chemicals in their daily activities. A guest speaker from the community (e.g. supermarket manager, fish plant worker, professional cleaners, janitorial staff, etc.) could be invited to give a brief presentation or talk about how chemicals or chemical processes are used in their workplace.

Controlling Chemical Reactions *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 99-103

TR: 2.40-2.41

BLM: 2.22

SRL: 145-146

Chemistry in Everyday Life

Outcomes

Students will be expected to

- identify new questions and problems that arise from what was learned: (210-16)
  - list the commonly used methods of preserving foods
  - categorize these methods into three main categories (methods):
    - (i) temperature control
    - (ii) chemical treatment (e.g. adding a preservative/inhibitor)
    - (iii) separating reactants (i.e. decreasing the concentration of a reactant; e.g. oxygen and water)
  - using the collision model, explain how various examples of food preservation work. Include:
    - (i) chilling milk
    - (ii) pickling beef (e.g. salt beef)
    - (iii) canned tuna
    - (iv) salting and drying fish
  - given a variety of fresh food choices, predict and justify an appropriate method of preservation

Elaborations—Strategies for Learning and Teaching

Teachers should ensure that students are aware of the relationship between the study of chemistry and food spoilage. Food spoils/rots/etc. due to a variety of chemical reactions that take place on or in the food. For example, cellulose is a material found in plants that helps give it its firmness. Plants get “mushy” or rot when the cellulose breaks down due to chemical changes.

When milk is chilled (temperature decrease) the atoms involved, on average, move slower, so the reactions that cause spoilage go more slowly. When salt is added to food, the salt acts as an inhibitor (i.e., the bacteria that normally cause rotting cannot live there).

Canning food removes oxygen (hear the “hiss” when you open the can). The sealed can stops collisions between reactants.

Salt is an inhibitor (see above). Drying removes water, which is an important reactant in the spoilage of food.

Teachers could ask students to perform the “Preserving Foods” activity on page 102 of the student text. Groups could come together to collaborate the results to create a class set of data to use when answering the questions. Teachers might want to extend the results over a longer time period (i.e. how good are each at preserving the fruit over longer time periods).

Justifications for preservation methods should consider the effect the method might have on taste and appearance of the food. Considerations for the ease of use of the method and the expense associated with the method should also be considered.

Chemistry in Everyday Life

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 100-103

TR: 2.42-2.45

SRL: 147-153

Recognizing Acids and Bases

Outcomes

Students will be expected to

- identify and evaluate potential applications of natural indicators (214-18)
  - define an indicator as any compound that changes color under different acidic conditions
- use instruments effectively and accurately for collecting data (213-3)
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- select and use apparatus and materials safely (213-8)
- classify substances as acids, bases, or salts, on the basis of their characteristic properties (319-2)
  - define acids operationally as solutions that:
    - (i) conduct electricity
    - (ii) turn blue litmus red
    - (iii) are sour tasting
    - (iv) react with metals
    - (v) react with bases

Elaborations—Strategies for Learning and Teaching

Natural indicators can be used to recognize whether a substance is acidic, basic, or neutral. The structure of the indicator molecule changes when it is in the presence of an acid or base. This change in structure causes the indicator to reflect a different colour (wavelength) of light. Indicators are special in that they will respond the same way and thus change their molecular shape regardless of the acid or base being used (e.g. lemon juice, vinegar, or hydrochloric acid will all produce the same change in the indicator).

The juice of many fruits and vegetables can be used as indicators. For example blueberries, beets, cranberries, red cabbage, all form natural indicators. However, chemists normally use synthetic chemical indicators as these are cheaper to produce, easier to store, and are better for use with specific acids/bases. Teachers can refer to pages 2-46 of the TR for a list of some common indicators and their various colours in acidic or basic conditions.

The skills outcomes 213-3, 213-5, 213-8 and others are addressed when students complete "*Recognizing Acids and Bases*". Core Activity 2.13.

Teachers could use BLM 2.13 to reinforce the topic of acid/base indicators.

Retain approximately 250 mL of the indicator solution for use in activity 2.16.

Teachers should caution students from tasting or touching any acids or bases without teacher's permission. Both of these methods of determining the identity or properties of a compound are frowned up today due to the inherent danger. In the past many chemists suffered from terrible diseases or afflictions due to tasting or improper handling of chemical compounds. In dilute form, acids and bases are relatively safe. However, concentrated acids or bases are corrosive particularly on skin and eyes. Students and teachers should always treat acids, bases and other chemicals as if they were highly dangerous. Many toxic compounds look like water. Proper safety procedures and equipment must be utilized when handling acids or bases (e.g. wear goggles, lab coat, gloves, etc.). Teachers and students should refer to the MSD Sheets of all acids or bases used. In general, if an acid or base comes in contact with skin, the best first aid treatment is to flush it with water (i.e. this dilutes the acid/base).

Salt is a general term used to describe any ionic compound. There are many different types of salt, not just sodium chloride (table salt).

Recognizing Acids and Bases

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 104-113

TR: 2.46-2.53

BLM: 2.23-2.25

SRL: 154-166

Recognizing Acids and Bases *(continued)*

Outcomes

Students will be expected to

- classify substances as acids, bases, or salts, on the basis of their characteristic properties (319-2) **Cont'd**
  - define bases operationally as solutions that:
    - (ii) conduct electricity
    - (ii) turn red litmus blue
    - (iii) taste bitter
    - (iv) react with acids
    - (v) feel slippery

Elaborations—Strategies for Learning and Teaching

Teachers could relate the properties of acids back to food preservation: bacteria do not survive in acidic conditions and hence dilute acids (e.g. vinegar) make good preservatives. Both acids and bases are used in cleaning products. Generally bases are more commonplace due to the fact that bases react with more of the things that are present in normal household cleaning areas. Some windshield washes are acidic as the stuff this is used to clean (e.g. bug juice) reacts better with acids and is therefore easier to remove from the windshield. Teachers could ask students to identify whether the cleaners in their homes are acidic or basic. Teachers could ask students to investigate and make their own "environmentally friendly" cleaners and test them against commercial cleaners to determine how effective they are.

Soap is made by combining a strong base with oil or fat (perfumes are added after). One of the properties of bases is that it is slippery to the touch. The reason for this is when base comes in contact with human skin, it reacts with the oils present and forms a soap. Teachers could ask students to research how soap is made. Note: students should not touch any chemical base.

Recognizing Acids and Bases *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 104-113

TR: 2.46-2.53

BLM: 2.23-2.25

SRL: 154-166

Neutralization Reactions

Outcomes

Students will be expected to

- describe how neutralization involves tempering the effects of an acid with a base and vice versa (321-2)

Elaborations—Strategies for Learning and Teaching

A base will react with an acid (or vice versa) to change it into water and an ionic compound (a salt). The base and acid will react with each other in a set ratio. When sufficient base is added to completely use up all the acid present, this point is called the neutralization point (i.e. the solution is neither acidic nor basic). On the way to neutralization, an acidic solution becomes less and less acidic as the base reacts with the acid present. The amount of base required to neutralize an acidic solution (and vice versa) will depend upon the concentration of the acid as well as the type of acid (i.e., strong or weak).

- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials (213-9)
- use instruments effectively and accurately for collecting data (213-3)
- identify and correct practical problems in the way a procedure is carried out (214-13)
- provide a statement that answers the question investigated in light of the link between data and the conclusion (214-11)

The skills outcomes 213-3, 213-9, 214-11, 214-13 and others are addressed when students complete "*Neutralizing Acids and Bases*". Core Activity 2.16.

In Part 1 of Core Activity 2.16 students record their observations. This is referred to as qualitative because the observations are descriptive in nature (e.g., quality). In Part 2 students make quantitative observations (i.e., make and record measurements). Pages 167-169 of the SRL provides all the space required to record data for the investigation as well as space for answering questions.

Teachers can refer to pages 2-55 of the TR for information on how to prepare the solutions required for this activity. Teachers can use the indicator solution they made in activity 2.13 as an appropriate indicator for Part 1 (step 2). To allow for easier dissolving of the baking soda and citric acid, teachers could ask students to add an additional 5 mL of distilled water (distilled water is neutral and will not affect the overall reaction). If citric acid is not available, teachers could substitute vitamin C tablets (ascorbic acid) which have been ground into a powder. For Part 2, teachers can opt to allow the liquid to evaporate (step 8) by leaving it in a warm area where it will not be disturbed or by placing it in an evaporating oven. If allowed to "air dry", teachers should allow for a 24 hour drying period.

Neutralization Reactions

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 112-113

TR: 2.54-2.56

SRL: 167-171

Understanding pH

Outcomes

Students will be expected to

- classify simple acids, bases and salts on the basis of their names and formulas: (319-2)
  - define strong and weak acids
  - define acids as molecules that ionize in water to produce hydrogen ions (H^+)
  - define bases as ionic compounds that contain the hydroxide ion (OH^-)
  - define salts as ionic compounds
  - define concentration as a measure of the amount of substance in a given volume
  - describe dissociation as the process by which compounds separate into ions in water
  - describe that an acid's reactivity is dependent upon:
    (i) concentration
    (ii) strength (degree of dissociation)
  - define pH scale as a measurement of the acidity of a solution
  - describe solutions that have:
    (i) pH < 7 as acidic
    (ii) pH > 7 as basic
    (iii) pH = 7 as neutral

Elaborations—Strategies for Learning and Teaching

With strong acids the hydrogen ion dissociates (separates from the rest of the compound and forms a 1+ ion) almost completely (i.e., almost 100% of the hydrogen ions separate from the compound). With weak acids hydrogen ions do not separate as easily from the compound (i.e. less than 50% of the hydrogen ions separate from the compound when it is dissolved in water). The more hydrogen ions that dissociate and go into solution, the stronger the acid that will be formed. Note, this not the same as concentration.

Concentration refers to the total amount of substance (acid) present in a given amount of solution, regardless of whether or not it dissociates into hydrogen ions. Teachers should ensure that students are aware of the distinction between strong acids and concentrated acids. Hydrochloric acid is a strong acid (i.e., it dissociates 100%). Acetic acid (used to make vinegar) is a weak acid. Both of these acids could be in concentrated form or in dilute form despite their relative dissociation abilities. For example in dilute form, acetic acid is used as vinegar to flavour foods; in concentrated form, it is very corrosive to living things. In dilute form, hydrochloric acid has very little effect on living tissue, while in concentrated form, it is very corrosive.

In general, the more concentrated the acid and the greater the degree of dissociation, the more reactive the acid will be.

Students may ask why stomach acid (hydrochloric acid) does not burn the stomach. In some cases it does (e.g., ulcers are formed when stomach acid "eats" at the lining of the stomach). However, in healthy systems, the stomach is coated with a layer of mucus which protects the stomach lining from coming in contact with the acid.

Teachers could use BLM 2.14 to review and reinforce the concept of strong and weak acids.

pH refers to the amount of hydrogen ions present in a solution (per hydrogen). The pH scale is a relative scale in which solutions can be ranked from very acidic to not very acidic (very basic). While the normal range of pH's on a pH scale is from 0 to 14, acidic solutions can have pH's of less than 0 and basic solutions can have a pH above 14.

Understanding pH

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 112-113

TR: 2.54-2.56

SRL: 167-171

ST: 114-117

TR: 2.56-2.61

BLM: 2.26-2.27

SRL: 172-177

Understanding pH *(continued)*

Outcomes

Students will be expected to

- provide examples of how chemistry is an integral part of their lives and their community (117-5)
  - describe the importance of maintaining a pH balance. Include:
    - (i) food digestion and nutrient absorption
    - (ii) soil
- use instruments effectively and accurately for collecting data (213-3)
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- state a prediction based on available evidence and background information (212-4)
- select and use apparatus and materials safely (213-8)

Elaborations—Strategies for Learning and Teaching

Students may not be aware of the numerous acid-base reactions that continuously occur in their daily lives. The ST (pages 114-115) describes two of these. Maintaining a balance between the acids and bases is very important as all living things have evolved to be able to tolerate a specific range of acidity. For example, some plants grow very well in acidic soil (e.g., moss) while others require less acidic (more basic) soil (e.g., grass). In order to maintain a healthy lawn, homeowners may have to add lime (a base) if the soil is too acidic. If they do not, then the grass will die and other plants such as moss will move in.

The skills outcomes 213-3, 213-5, 213-8, 212-4, and others are addressed when students complete "*The pH Scale and the pH of Household Products*". Core Activity 2.18.

Most indicators are useful for only a small pH range. Universal indicator, which is a combination of several indicators, is used in this activity. It has a range from 2 to 14 which makes it very useful when working with a wide variety of substances such as in this activity.

Teachers should ensure students follow the proper procedure for the use of droppers (see the caution information on page 117 of ST).

Because many household products contain corrosive materials, teachers should refer to the "safety considerations" section on pages 2-60 of the TR to ensure safety during this activity. These suggestions include protection of skin and eyes, procedures in case of spills, proper dropper use, and cleanup procedures.

Teachers could use BLM 2.18a to help students organize their household products for testing. Teachers could ask students to use the report template on pages 174-175 of the SRL to record observations and complete analysis of the results.

Understanding pH *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 118-119

TR: 2.62-2.64

BLM: 2.30

SRL: 178-181

Acids & Bases in Everyday Life

Outcomes

Students will be expected to

- analyze the risks and benefits to society and the environment of applying knowledge of acids and bases to air pollution (118-2)
  - describe how rainwater becomes acidic. Include:
    - (i) naturally
    - (ii) artificially
  - describe some sources of chemicals that produce acid rain. Include:
    - (i) carbon dioxide sources
    - (ii) nitrogen oxide(s) sources
- propose a course of action on reducing acid rain, taking into account human and environmental needs (118-9)

Elaborations—Strategies for Learning and Teaching

Teachers should refer to page 118 of the ST for information on this outcome.

Natural sources include carbon dioxide produced by animals and decomposition of organic materials, naturally-caused fires, and sulphur oxides that come from volcanoes. Artificial sources refer to emissions that result from the actions of humans (e.g. industrial activities, burning fossil fuels for heat or for transportation, etc.).

Teachers could ask students to complete the Extension Activity “Air Pollution and Acid Rain” on page 178 of the SRL as a means of exploring this topic a bit more deeply. Students could work in groups of 2 or 3 initially and then report their findings/conclusions to the class as part of a whole class discussion.

Teachers should relate the formation of air pollutants back to the formation of acid rain. For example, the burning of fossil fuels has the multiple effect of polluting the air (i.e. more carbon dioxide, more sulphur dioxide, more nitrogen oxides, etc.) and contributing to the formation of acid rain. The various oxide pollutants react with water in the air and form several types of acids. These acids fall to the ground and exert a harmful effect on living things, as well as the physical and natural environment.

An example of a reaction that causes acid rain is the reaction of carbon dioxide and water which produces carbonic acid. $CO_2 + H_2O \rightarrow H_2CO_3$

Sulphur dioxide reacts with water to form sulfuric acid. $SO_2 + H_2O \rightarrow H_2SO_3$

Teachers could ask students to complete the Take a Stand activity “The Use of Cars Should be Restricted” (page 119) to help them develop an idea that there are no simple solutions to the problems of acid rain. In groups of 2 or 3, students could list the pros and cons of the proposition described. Students could debate the relative merits of this proposition. When developing their action plans, students should consider the effects their strategy would have on community members, the costs involved, the practicality of the idea, the likelihood of wide scale acceptance, the implementation timelines, etc. Students could create a media campaign for their school or community, outlining the dangers of acid precipitation, the causes, the possible solutions, etc. Teachers could ask students to use the template on pages 179-180 of the SRL to help them organize their discussion.

Acids & Bases in Everyday Life

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 120-123

TR: 2.65-2.68

SRL: 182-198

Acids & Bases in Everyday Life *(continued)*

Outcomes

Students will be expected to

- evaluate the effectiveness of antacids and the way they function, using scientific principles (116-6)
- design an experiment identifying and controlling major variables (212-3)
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- provide examples of how science and technology are an integral part of their lives and their community by investigating chemistry in the workplace. (117-5)
- identify and describe careers related to the chemistry they are studying (117-7)

Elaborations—Strategies for Learning and Teaching

The skills outcomes 212-3, 213-5, 213-8, STSE outcome 116-6, and others are addressed when students complete "*Testing Antacids*". Core Activity 2.20.

Teachers should ensure that students use the "fair test" approach during this investigation (i.e., that variables are controlled). Refer to "teaching suggestions" on pages 2-64 of the TR for information on conducting a fair test of the various antacids, preparing the "stomach acid" solution, and how to ensure effective use of time during this activity.

Teachers could refer students to pages 258-274 of the ST to review the skills associated with conducting an experiment. In particular, teachers may wish to review the process of graphing data (pages 290-292 of the ST) with their students.

Teachers could ask students to use the report template on pages 182-185 of the SRL to record observations and complete analysis of the results.

The CORE STSE component of this unit incorporates a broad range of Science 3200 outcomes. More specifically, it targets (in whole or in part) 117-5, 117-7, 321-1, 214-6 and their delineations. The STSE component, *Chemistry at Work,* can be found in Appendix A.

Acids & Bases in Everyday Life *(continued)*

Suggested Assessment Strategies

Resources

www.gov.nl.ca/edu/science_ref/main.htm

ST: 120-127

TR: 2.65-2.68

BLM: 2.5-2.6

SRL: 122-189

Core STSE #6: *Chemistry at Work,* **Appendix A**

Summary Text

ST: 124-129

TR: 2.69-2.72

SRL: 190-192