Senior 2

Cluster 2: Chemistry in Action

Overview

This cluster provides students with the opportunity to examine the interactions among elements as they form compounds through chemical reactions. Students become familiar with the formulas and naming of binary compounds, and investigate the Law of Conservation of Mass. The recognition that mass is conserved in chemical reactions allows students to balance equations with both words and symbols, and classify them by type. The principles of acid-base chemistry are studied and extended to large-scale environmental interactions. Students investigate the use of chemistry in biological, industrial, and domestic settings, recognizing that chemical use is pervasive in modern society.

Prescribed Learning Outcomes

Students will...

S2-2-01 Relate an element's position on the periodic table to its combining capacity (valence).

Include: alkali metals, alkaline earth metals, chalcogens, halogens, noble gases

GLO: D3, D4, E1

Suggestions for Instruction

(1 hour)

➢ Notes for Instruction

A review of atomic structure and Bohr models, as well as the design of the periodic table from Senior 1, may be a starting point for this cluster. A Knowledge chart or Sort and Predict activity may be used (see *SYSTH* 9.25, 10.23).

Bohr diagrams are useful to illustrate the number of electrons found within the valence shells, and to help students visualize how atoms lose, gain, or share electrons to fill their valence shells and become stable.

Introduce electron (Lewis) dot diagrams as an alternative means of representing atoms and their valence electrons. They are valuable tools for describing, predicting, and explaining compound formation. Have students draw electron dot diagrams for the first 20 elements on the periodic table. It is strongly recommended that details of the periodic table not be memorized. However, the characteristics of the periodic table do provide a powerful conceptual and organizational tool.

➢ Student Learning Activities

Class Discussion

Examine how the periodic table and Bohr models are used to determine the combining capacity of selected element groups. Have students brainstorm answers to questions such as "Why do elements of the same group have similar properties?" and "What is it about the properties of metals and non-metals that allow one to predict the types of compounds they are likely to form?" Knowing the number of valence electrons will help students predict the formation of compounds.

Visual Displays/Collaborative Teamwork S2-0-2c, 5c

Students or student groups create posters illustrating Bohr models and electron (Lewis) dot diagrams for the first three elements found within the alkali metal, alkaline earth metal, chalcogen, halogen, and noble gas families. The displays can be exhibited in the room for future reference. See Appendix 2.1 for Lewis dot diagrams.

Journal Entry S2-0-7f

Students complete a Word Cycle of terms related to this topic (see *SYSTH* 10.21).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2c, 5c

Students or student groups present their posters. Repetition occurring for the number of valence electrons found within each of the families should be noted.

Journal Writing S2-0-7f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- draw Bohr models of atoms when provided with their atomic mass and atomic number
- draw electron (Lewis) dot diagrams of atoms
- predict the number of valence electrons present in an atom from its position on the periodic table
- identify the location of the following families on the periodic table: alkali metals, alkaline earths, chalcogens, halogens, noble gases
- predict whether an atom will lose, gain, or share electrons, based on its position on the periodic table
- explain why atoms lose, gain, or share electrons
- complete a Word Cycle of the following terms: *valence, period, noble gas, periodic table, atom, metals, halogens, atomic number, family* (see *SYSTH* 10.21)

Teacher Background

Elements in the same group have similar properties because they have the same number of electrons in their outer shell. The outer electron shell of an atom is also known as the valence shell. The electrons in this shell are called valence electrons.

The arrangement of the valence electrons is key to understanding the formation of compounds. Chemical bonds form when atoms combine with other atoms by transferring or sharing electrons in an attempt to fill their valence electron shells.

Suggested Learning Resources

Science 10

5.5 Elements and the Periodic Table

BLM 5.5a Periodic Table of the Elements

Science Power 10

5.1 Looking for Patterns in Chemical Reactivity

BLM 5-2 Periodic Table Scavenger Hunt

BLM 5-3 Anatomy of an Atom

BLM 5-6 Electron Shells

BLM 5-9 Reviewing the Periodic Table of the Elements

SYSTH

9.25 Knowledge Chart

10.21 Word Cycle

10.23 Sort and Predict

13.21 Journal Evaluation

Appendices

2.1 Lewis Dot Diagrams

6.1 Rubric for the Assessment of Class Presentations

Prescribed Learning Outcomes
Students will...
S2-2-02 Explain, using the periodic table, how and why elements combine in specific ratios to form compounds. Include: ionic bonds, covalent bonds GLO: D3, E2

Suggestions for Instruction
(2 hours)

➢ Entry-Level Knowledge

In Senior 1, students differentiated between elements and compounds, and interpreted chemical formulas of elements and compounds in terms of the number of atoms of each element present.

➢ Notes for Instruction

When discussing the formations of compounds with students, it is important to focus on the "why" before the "how." Students must have a firm understanding of the reasons why atoms lose/gain/share electrons to obtain a full valence electron arrangement.

Use electron (Lewis) dot diagrams to demonstrate why and how atoms lose or gain electrons to form ions.

Use electron (Lewis) dot diagrams to demonstrate why and how non-metal atoms share electrons.

Teacher Background

Only electrons are involved in bond formation, as protons are tightly held in the nuclei of atoms.

Noble gases do not form chemical bonds with other elements due to their full valence shells. They are chemically stable. An atom may acquire a valence shell like that of its closest noble gas in one of three ways: gaining, losing, or sharing electrons.

When a neutral metal atom loses an electron, a positively charged ion forms. When a neutral non-metal atom gains an electron, a negatively charged ion forms. Ionic bonds are a result of the forces of attraction between positive and negative ions.

When electrons are shared between two non-metal atoms, a covalent bond forms. The resulting particle is called a molecule.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c

Students or student groups present
- posters
- charts
- bulletin board displays
- concept maps
- models

Journal Writing S2-0-2a

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- explain why atoms combine in specific ratios to form compounds
- predict whether a compound contains ionic or covalent bonds, given its chemical formula
- explain why the noble gases do not form chemical bonds
- compare and contrast ionic and covalent bonds
- draw Bohr models or electron (Lewis) dot diagrams of compounds with ionic bonds
- give examples of compounds that contain ionic bonds
- draw Bohr models or electron (Lewis) dot diagrams of compounds with covalent bonds
- give examples of compounds that contain covalent bonds
- list the elements found as diatomic molecules
- explain why diatomic molecules are classified as elements and not compounds, even though they contain chemical bonds

Suggested Learning Resources

Science 10

5.6 How Elements Form Compounds

5.7 Activity: Ionic Charges and Chemical Families

BLM 2.1 Atoms, Elements, and Compounds

BLM 5.7a Ionic Charges and Chemical Families, A

BLM 5.7b Ionic Charges and Chemical Families, B

BLM 5.7c Ionic Charges and Chemical Families, C

Science Power 10

5.1 Looking for Patterns in Chemical Reactivity

5.2 Forming Compounds

Investigation 5-A: Ionic or Covalent—Track Those Electrons

BLM 5-4 Anatomy of an Ion

BLM 5-5 Keeping an ION That Electron

BLM 5-11 Ionic and Covalent Bonding

SYSTH

10.24 Compare and Contrast

13.21 Journal Evaluation

Appendix

Rubric for the Assessment of a Class Presentation

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-02 Explain, using the periodic table, how and why elements combine in specific ratios to form compounds.

Include: ionic bonds, covalent bonds

GLO: D3, E2

SUGGESTIONS FOR INSTRUCTION

(2 HOURS)

➢ Student Learning Activities

Class Discussion

Illustrate the process by which a neutral sodium atom loses an electron to achieve the same electron arrangement as the noble gas neon.

Illustrate the process by which a neutral chlorine atom gains an electron to achieve the same electron arrangement as the noble gas argon.

Illustrate the process by which a neutral non-metal atom such as carbon shares electrons with another neutral non-metal atom to obtain a full valence shell.

Collaborative Teamwork S2-0-4f

Student groups construct Bohr or electron (Lewis) dot models of a variety of compounds containing ionic and covalent bonds. Examples may include NH_3 (ammonia), CH_4 (methane), H_2O (water), NaCl (sodium chloride), CaF_2 (calcium fluoride), MgS (magnesium sulfide), and Li_2O (lithium oxide). Diatomic molecules such as F_2, H_2, and Cl_2 can also be used.

Visual Display S2-0-2a, 5c

Students or student groups construct visual displays of compounds containing ionic and covalent bonds. Displays may include posters, charts, bulletin boards, concept maps, and models, and can be exhibited in the room for future reference.

Journal Writing S2-0-2a

Students compare and contrast ionic and covalent bonds (see *SYSTH* 10.24).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

S2-2-03 Write formulas and names of binary ionic compounds.

Include: IUPAC guidelines and rationale for their use

GLO: A2, C2, D3, E1

Suggestions for Instruction
(2 hours)

➢ Entry-Level Knowledge

In Senior 1, students examined the relationship among atoms, elements, and compounds. In addition, they interpreted chemical formulas of elements and compounds in terms of the number of atoms of each element.

➢ Notes for Instruction

Discuss only binary ionic compounds. Students may ask about compounds that contain polyatomic ions (e.g., sodium nitrate, $NaNO_3$), but these will be examined in Senior 3 Chemistry.

Where circumstances are appropriate, treatment of polyatomic ions is encouraged as an extension for interested students. Avoid formal assessment of working with polyatomic ions in formulas.

Emphasize the need for a global naming system. Compounds named using IUPAC guidelines name the positive ion first by writing the full name of the metallic element. The non-metal ion is then named by changing the last syllable to "ide."

Use the Stock (Roman numeral) system to name compounds in which the metal ion can have more than one charge. Students may have difficulty determining the Stock system name from a chemical formula. Provide students with plenty of opportunities for practice. See Appendix 2.7: Ionic Compounds (Teacher Support Material).

➢ Student Learning Activities

Collaborative Teamwork S2-0-4f, 8b

Students work in pairs and practise naming binary ionic compounds.

Examples: MgO = magnesium oxide, $NiCl_3$ = nickel (III) chloride, $CaBr_2$ = calcium bromide

Students work in pairs and practise writing chemical formulas for binary ionic compounds.

Examples: potassium nitride = K_3N, aluminum fluoride = AlF_3, tin (IV) sulfide = SnS_2

(continued)

SUGGESTIONS FOR ASSESSMENT

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c

Students or student groups present
- posters
- charts
- bulletin board displays
- concept maps

Journal Writing S2-0-2c

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- differentiate between elements and compounds
- interpret chemical formulas in terms of the number of atoms of each element present
- write the name of an ionic compound, given its formula
- write the formula of an ionic compound, given its name
- discuss the importance of the IUPAC system in naming compounds
- explain why the Stock (Roman numeral) system is needed for naming some compounds
- identify metals that, when found in compounds, are likely to require the use of the Stock system in naming

Teacher Background

The Stock (Roman numeral) system is used only if the metal ion in the compound can have more than one charge. Many transition metals form ions with a variety of charges. For example, iron ions may have a charge of 2+ or 3+, and form the compounds $FeCl_2$ and $FeCl_3$. Both compounds would therefore be named iron oxide. In order to differentiate between the two compounds, a Roman numeral is used to indicate the charge of the metal ion. Thus, $FeCl_2$ is iron II chloride and $FeCl_3$ is iron III chloride.

SUGGESTED LEARNING RESOURCES

Science 10

5.8 Ionic Compounds

BLM 5.8 Ionic Compounds: Names and Formulas

Science Power 10

5.3 Chemical Names and Formulas

Investigation 5-C: Writing Names and Formulas of Binary Ionic Compounds

BLM 5-14 Writing Names and Formulas

SYSTH

11.14 Chain Concept Map

13.21 Journal Evaluation

Appendices

2.7 Ionic Compounds

6.1 Rubric for the Assessment of Class Presentations

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-03 Write formulas and names of binary ionic compounds.

Include: IUPAC guidelines and rationale for their use

GLO: A2, C2, D3, E1

SUGGESTIONS FOR INSTRUCTION

(2 HOURS)

Visual Display S2-0-2a, 5c

Students or student groups construct visual displays of the names and formulas of ionic compounds. Displays may include posters, charts, bulletin boards, or concept maps, and can be exhibited in the room for future reference.

Journal Writing S2-0-2c

Students prepare Chain Concept Maps outlining the steps used in naming and determining the formulas of ionic compounds (see *SYSTH* 11.14).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

S2-2-04 Write formulas and names of molecular compounds using prefixes.

Include: mono, di, tri, tetra

GLO: C2, D3, E1

Suggestions for Instruction

(2 hours)

➢ Entry-Level Knowledge

In Senior 1, students examined the relationship among atoms, elements, and compounds. In addition, they interpreted chemical formulas of elements and compounds in terms of the number of atoms of each element.

➢ Notes for Instruction

Binary molecular compounds contain atoms of two non-metals, bonded covalently by sharing electrons.

Following IUPAC guidelines, the molecular compounds are named using a prefix system. A Greek prefix is used to indicate the number of each kind of covalently bonded atom in the molecule. Prefixes should be memorized for instant recall. See Appendix 2.8: Molecular Compounds (Teacher Support Material). Encourage the use of prefixes such as "penta" and "hexa" where circumstances permit. Students, however, should not be expected to go beyond hexavalent species.

The naming system used for organic compounds such as methane (CH_4) and ethanol (CH_3–CH_2–OH) will be studied in Senior 3 Chemistry.

➢ Student Learning Activities

Collaborative Teamwork S2-0-4f, 8b

Students work in pairs and practise naming binary molecular compounds. Examples: CO = carbon monoxide, SO_2 = sulfur dioxide, PCl_5 = phosphorous pentachloride

Students work in pairs and practise writing chemical formulas for binary molecular compounds.
Examples: sulfur hexafluoride = SF_6, dinitrogen tetroxide = N_2O_4, nitrogen tribromide = NBr_3

Visual Display S2-0-2a, 5c

Students or student groups construct visual displays of the names and formulas of ionic compounds. Displays may include posters, charts, bulletin boards, or concept maps, and can be exhibited in the room for future reference.

Journal Writing S2-0-2c

Students prepare Chain Concept Maps outlining the steps used in naming and determining the formulas of molecular compounds (see *SYSTH* 11.14).

SUGGESTIONS FOR ASSESSMENT

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c

Students or student groups present
- posters
- charts
- bulletin board displays
- concept maps

Journal Writing S2-0-2c

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- differentiate between elements and compounds
- interpret chemical formulas in terms of the number of atoms of each element present
- write the name of a molecular compound, given its formula
- write the formula of a molecular compound, given its name
- discuss the importance of the IUPAC system in naming compounds
- explain why Greek prefixes are needed in naming molecular compounds
- distinguish among the various Greek prefixes used in naming molecular compounds
- predict why diatomic molecules are considered to be elements and not compounds, even though they contain covalent bonds

SUGGESTED LEARNING RESOURCES

Science 10

5.11 Molecular Compounds

BLM 5.11 Molecular Compounds: Names and Formulas

Science Power 10

5.3 Chemical Names and Formulas

BLM 5-14 Writing Names and Formulas

SYSTH

11.14 Chain Concept Map

13.21 Journal Evaluation

Appendices

6.1 Rubric for the Assessment of Class Presentations

2.8 Molecular Compounds

Teacher Background

The Greek prefixes used in naming molecular compounds are:

mono = 1
di = 2
tri = 3
tetra = 4
penta = 5
hexa = 6

Prescribed Learning Outcomes
Students will...
S2-2-05 Investigate the Law of Conservation of Mass and recognize that mass is conserved in chemical reactions. GLO: A2, D3, D4, E3

Suggestions for Instruction

(2 hours)

➢ Entry-Level Knowledge

In Grade 5, students were first introduced to physical and chemical changes and examined them again in Senior 1 Science, along with the indicators of chemical change.

➢ Notes for Instruction

Activate student knowledge of chemical and physical changes, as well as the indicators of chemical change, with a KWL or Knowledge chart (see *SYSTH* 9.24, 9.25).

A review of science safety procedures and WHMIS is appropriate at this time. Demonstration and laboratory activities may involve dangerous chemicals. Ensure everyone is aware of laboratory safety and chemical disposal procedures, household and workplace hazard symbols, and WHMIS regulations (see *Science Safety,* Manitoba Education and Training, 1997).

Because the Law of Conservation of Mass states that matter is neither created nor destroyed, matter cannot simply appear or disappear. This gives stability to our world. Ask students to speculate how their world would be different if the Law of Conservation of Mass did not exist.

➢ Student Learning Activities

Laboratory Activity S2-0-3c, 4b, 4c, 4d

Students perform a laboratory activity investigating the Law of Conservation of Mass by comparing the mass of reactants to the mass of products. See Appendix 2.5: Law of Conservation of Mass.

Visual Display S2-0-4b, 4c, 4d

Students or student groups create visual displays of laboratory safety equipment, techniques, and procedures. Examples may include

- demonstrating correct use of safety goggles
- demonstrating correct handling and disposal of broken glass
- demonstrating correct and safe operation of a Bunsen burner

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-5b, 5c, 6a, 6b

Students interpret their laboratory results, and prepare a report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Visual Display S2-0-4b, 4c, 4d

Students or student groups present their findings of laboratory safety equipment, techniques, and procedures with
- posters
- cartoons
- charts
- multimedia presentations
- brochures
- pamphlets
- dramatic presentations

Journal Writing S2-0-8c, 8e, 9a

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

(continued)

Suggested Learning Resources

Science 10

5.1 Chemicals and Chemical Change

5.2 Case Study: Hazardous Household Chemicals

6.2 Investigation: Measuring Masses in Chemical Changes

6.3 Conserving Mass

6.4 Finding the Missing Mass

BLM 5.1c Safety Symbols

BLM 5.1d Lab Safety Concept Map

BLM 6.2 Measuring Masses in Chemical Changes

Science Power 10

Investigation 5-E: Comparing the Masses of Reactants and Products

BLM G-3 Using a Balance

BLM G-6 Safety Scavenger Hunt

BLM G-7 Safety Contract

BLM G-8 Safety Checklist

BLM G-9 WHMIS Symbols and Hazardous Household Products Symbols

SYSTH

9.24 KWL Plus Knowledge Chart

13.21 Journal Evaluation

13.23 RAFTS

14.12 Lab Report Format

Science Safety

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-05 Investigate the Law of Conservation of Mass and recognize that mass is conserved in chemical reactions.

GLO: A2, D3, D4, E3

SUGGESTIONS FOR INSTRUCTION

(2 HOURS)

Journal Writing S2-0-8c, 8e, 9a

Have students imagine they are Antoine or Marie-Anne Lavoisier. They have discovered the Law of Conservation of Mass, but one of them has been imprisoned during the French Revolution. They write an appeal to a judge requesting their release. A RAFTS format could be used (see *SYSTH* 13.23).

Collaborative Teamwork S2-0-4c, 4d, 4f

Students design and evaluate a game that teaches WHMIS or consumer labeling. Games should include all necessary playing pieces, instructions, and scoring.

Students play and evaluate each other's games.

Class Discussion S2-0-7f, 9b

The Law of Conservation of Mass has implications far beyond the lab. For example, when a car burns gasoline, the energy produced in the chemical reaction is used to move the car. However, since mass is conserved, the mass of the fuel and oxygen consumed is still present in another form. (The balanced equation is $2\ C_8H_{18} + 9\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$.) Ask students to speculate on the implications of the Law of Conservation of Mass in their daily lives.

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- state the Law of Conservation of Mass
- recognize that mass is conserved in a chemical reaction
- relate the Law of Conservation of Mass to events in their daily lives
- identify WHMIS symbols
- interpret a WHMIS label
- identify and suggest corrections for potentially unsafe laboratory situations

Teacher Background

French chemists (and spouses) Antoine and Marie-Anne Lavoisier, conducted many experiments with chemical reactions in the late 18th century. They demonstrated that oxygen is required for combustion to occur. Their belief in the need to make exact measurements during experiments led them to recognize that mass is conserved in chemical reactions.

The Lavoisiers saw the need for change in pre-revolutionary France. Antoine was actively involved in committees proposing legislative, social, economic, and tax reform. Because he was a moderate, Marat and other radicals held him in contempt. He was arrested during the Reign of Terror and imprisoned. When Antoine requested time to complete some scientific work, the judge at his trial is said to have replied, “The Republic has no need of scientists.” Antoine was guillotined in May of 1794. Marie-Anne survived this period of hostility, and later married the American scientist Benjamin Thompson. Thompson endeared himself to the Bavarian scientific establishment, and was awarded the title “Count Rumford.”

Suggested Learning Resources

Appendices

2.5 Student Learning Activity: Law of Conservation of Mass

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-2-06 Balance chemical equations. Include: translation of word equations to balanced chemical reactions, and balanced chemical equations to word equations GLO: C2, D3

SUGGESTIONS FOR INSTRUCTION
(3 HOURS)

➢ Notes for Instruction

Introduce the learning outcome by first modeling the balancing of skeleton equations. The terms *reactant, product, subscript,* and *coefficient* should be clarified. Provide students with opportunities for practice and feedback. As students progress, discuss physical state symbols and translation of word and chemical equations.

The translation of chemical equations into word equations (and vice versa) requires students to use their prior knowledge from learning outcomes S2-2-03 and S2-2-04. Remind students of this, and provide them with opportunities for practice and feedback. Ensure that physical state symbols (i.e., (s), (aq), (g)) are adequately explained to students.

➢ Student Learning Activities

Collaborative Teamwork S2-0-4f, 6a 6b

Students work in groups to balance skeleton equations. They should verify that chemical equations have been correctly balanced and, if not, identify where errors were made.

Students work in groups to translate equations and balance reactions. They should verify that chemical equations have been correctly translated and balanced and, if not, identify where errors were made. See Appendix 2.4: Balancing Chemical Equations.

Visual Display S2-0-2c, 4e

Students prepare models representing the process of balancing chemical equations. Bingo chips or candies of different colours could be used to represent the different atoms. Students should also write the balanced chemical reactions on their display.

Journal Writing S2-0-2c, 8b

Students create a glossary of new words for quick reference. A Three-Point Approach could be used (see *SYSTH* 10.22).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display/Performance Assessment S2-0-2c, 4e

Students present their models of chemical reactions, including the balanced chemical equation.

Journal Writing S2-0-2c, 8b

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- explain the relationship between balancing equations and the Law of Conservation of Mass
- differentiate between subscripts and coefficients
- balance skeleton equations by adding coefficients
- identify the physical state symbols used in chemical equations
- verify that chemical equations have been correctly balanced and, if not, identify where errors were made
- differentiate between reactants and products
- relate the conservation of mass to the conservation of atoms in chemical reactions
- translate word equations into balanced chemical reactions
- translate balanced chemical reactions into word equations
- verify that chemical equations and reactions have been correctly balanced and translated and, if not, identify where errors have been made

Teacher Background

Equations are balanced using four basic steps:

1. Count the number of atoms of each element on each side of the arrow.
2. Never change subscripts. This changes the substances present. For example, H_2O is water and H_2O_2 is hydrogen peroxide.
3. Change only the coefficients.
4. Use trial and error.

Suggested Learning Resources

Science 10

6.1 Word Equations

6.5 Balancing Chemical Equations

BLM 6.5a How to Count Atoms Review

BLM 6.5b Counting Atoms

BLM 6.5c Balancing Equations

Science Power 10

5.4 Chemical Equations And Chemical Reactions

BLM 5-18 Chemical Equations and Their Parts

BLM 5-19 Balancing Chemical Equations

BLM 5-20 Chemical Equations

SYSTH

10.22 Three-Point Approach

13.21 Journal Evaluation

Appendices

2.4 Student Learning Activity: Balancing Chemical Equations

6.1 Rubric for the Assessment of Class Presentations

PRESCRIBED LEARNING OUTCOMES

Students will...

S2-2-07 Investigate and classify chemical reactions as synthesis, decomposition, single displacement, double displacement, or combustion.

GLO: D3, D4, E3

SUGGESTIONS FOR INSTRUCTION
(3 HOURS)

➢ Entry-Level Knowledge

In Senior 1, students experimented to determine the indicators of chemical change, such as colour change, production or absorption of heat and/or light, and production of gas or precipitate.

➢ Notes for Instruction

Include demonstrations and/or lab activities to address this learning outcome. Students can only classify reactions when provided with both the reactants and the products. For example, given $Mg + O_2 \rightarrow MgO$, a student should identify this as a synthesis reaction.

Demonstration and laboratory activities may involve dangerous chemicals. Ensure everyone is aware of laboratory safety and chemical disposal procedures, household and workplace hazard symbols, and WHMIS regulations (see *Science Safety,* Manitoba Education and Training, 1997).

➢ Student Learning Activities

Laboratory Activity/Teacher Demonstration
S2-0-3a, 4b, 4c, 4d

Perform experiments that demonstrate the five types of chemical reactions. Some examples are

- Synthesis
  - — Add powdered zinc to powdered sulfur in equal amounts (in fume hood). Burn magnesium in the blue flame of a Bunsen burner.
- Decomposition
  - — Break water down into oxygen and hydrogen with electrolysis. Heat copper sulfate pentahydrate.
- Single displacement
  - — Place aluminum foil in a solution of iron (III) nitrate, or place a copper wire in a silver nitrate solution.
- Double displacement
  - — Add potassium iodide solution to lead (II) nitrate solution. Add sodium hydroxide solution to copper sulfate or copper chloride solution.
- Combustion
  - — Burn a candle or light a Bunsen burner. Strike a match.

See Appendix 2.6: Experiment: Reaction Types.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-5c, 6a, 6b, 7a

Students interpret their laboratory results, and prepare a report of their findings (see *SYSTH* 14.12 for report format). Word-processing software and spreadsheets can be used for report writing.

Performance Assessment S2-0-4b, 4c

Students demonstrate their ability to follow science safety procedures or interpret a WHMIS label.

Teacher Background

There are many methods for classifying chemical reactions, and some reactions may be a combination of more than one type. The five types to be examined in this learning outcome are

1. Synthesis (combination)
   two or more elements or compounds fi compound
   (i.e., A + B fi AB)
2. Decomposition
   compound fi two or more elements or compounds
   (i.e., AB fi A + B)
3. Single displacement (replacement)
   element + compound fi element + compound
   (i.e., A + BC fi B + AC)
4. Double displacement (replacement)
   compound + compound fi compound + compound
   (i.e., AC + BD fi AD + BC)
5. Combustion
   hydrocarbon + oxygen fi carbon dioxide + water

(continued)

Suggested Learning Resources

Science 10

6.6 Combustion

6.7 Types of Chemical Reactions: Synthesis and Decomposition

6.8 Investigation: Putting Things Together

6.9 Investigation: Taking Things Apart

6.10 Types of Chemical Reactions: Single and Double Displacement

6.11 Investigation: Single Displacement Reactions

6.12 Investigation: Double Displacement Reactions

6.13 Activity: Putting It All Together

BLM 6.8 Putting Things Together

BLM 6.9 Taking Things Apart

BLM 6.11 Single Displacement Reactions

BLM 6.12 Double Displacement Reactions

BLM 6.13 Types of Chemical Reactions

Science Power 10

6.2 Synthesis and Decomposition Reactions

6.3 Single Displacement and Double Displacement Reactions

Investigation 6-C: Putting It Together: Classifying Chemical Reactions

6.4 Reaction Involving Carbon Compounds

BLM 6-8 Single and Double Displacement Reactions

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-07 Investigate and classify chemical reactions as synthesis, decomposition, single displacement, double displacement, or combustion.

GLO: D3, D4, E3

SUGGESTIONS FOR INSTRUCTION
(3 HOURS)

Visual Display/Collaborative Teamwork S2-0-2a, 2c, 4f, 4g

Student groups construct visual displays to illustrate the five types of chemical reactions.

Class Discussion S2-0-7f

Discuss the five types of chemical reactions. Students should brainstorm examples from daily life, such as burning gasoline (combustion), digesting food (decomposition), iron rusting (synthesis), water softeners (double displacement), and copper bracelets that turn skin green (single displacement).

Journal Writing S2-0-2c, 8b

Students complete a Three-Point Approach to summarize the different types of chemical reactions (see *SYSTH* 10.22).

Suggestions for Assessment

Visual Display S2-0-5c, 8b, 9b

Student groups present their findings of the various types of chemical reactions with

- posters
- diagrams
- bulletin boards
- charts
- concept maps

Journal Writing S2-0-2c, 8b

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- list the indicators of chemical change
- classify chemical reactions as synthesis, decomposition, single displacement, double displacement, or combustion
- list examples of the five types of chemical reactions
- discuss everyday uses of the five types of chemical reactions
- identify WHMIS symbols
- interpret a WHMIS label
- identify and suggest corrections for potentially unsafe laboratory situations

Suggested Learning Resources

BLM 6-11 Putting It Together: Classifying Chemical Reactions

SYSTH

10.22 Three-Point Approach

13.21 Journal Evaluation

14.12 Lab Report

Science Safety

Appendices

2.4 Balancing Chemical Equations

2.6 Experiment: Reaction Types

6.1 Rubric for the Assessment of Class Presentations

6.4 Lab Report Assessment

Prescribed Learning Outcomes

Students will...

S2-2-08 Experiment to classify acids and bases using their characteristic properties.

Include: indicators, pH, reactivity with metals

GLO: D3, E1

Suggestions for Instruction

(2 hours)

➢ Notes for Instruction

Activate student knowledge about the topic and note any misconceptions; focus on the correct use of terminology in science. Introduce the pH scale as a method of representing the acidity or alkalinity of a solution. Students have not been introduced to ions, so avoid a discussion of hydrogen and hydroxide ions, or $pH = -\log[H_3O^2]$.

Introduce students to the names and formulas of common acids and bases, such as

- Hydrochloric acid: HCl
- Sulfuric acid: H_2SO_4
- Nitric acid: HNO_3
- Sodium hydroxide: NaOH
- Calcium hydroxide: $Ca(OH)_2$
- Ammonium hydroxide: NH_4OH

Include demonstrations and/or lab activities to address this learning outcome. Take appropriate safety precautions when handling acids and bases, and reinforce WHMIS regulations.

➢ Student Learning Activities

Class Discussion S2-0-7f, 8b, 9b

Write the term "ACID" on the chalkboard, ask students to brainstorm, and write down what comes to mind when they see the word. A Rotational Cooperative Graffiti format could be used (see *SYSTH* 3.15).

Teacher Background

Indicators are substances whose colour varies, depending on the pH of a solution. For example, phenolphthalein is colourless in solutions with a pH below 8, and pink in solutions with a pH of above 10. Bromthymol Blue is yellow when the pH of a solution is below 6, green at a pH of 7, and blue above a pH of 8. Universal Indicator is a solution containing several indicators and can also be found in pH test strips.

(continued)

SUGGESTIONS FOR ASSESSMENT

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Performance Assessment S2-0-4a, 4b, 4d, 5a

Students test unknown solutions and identify them as acids or bases, based on their characteristic properties.

Students demonstrate safe handling and disposal of acids and bases in the lab.

Laboratory Report S2-0-6a, 6b, 7a, 7b

Students interpret their laboratory results and prepare a report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Journal Writing S2-0-2c

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- identify the names and formulas of common acids and bases
- describe the pH scale
- predict if a substance is an acid or base, based on characteristic properties
- compare and contrast the properties of acids and bases (see *SYSTH* 10.24, 11.21)
- identify the acid/base colours of common indicators
- describe safe handling and disposal of acids and bases in the lab
- differentiate between strong acids and weak acids, and strong bases and weak bases, in terms of their pH

Teacher Background

The pH scale measures the acidity or alkalinity of a solution. The scale ranges between 0 and 14. Acids have a pH of less than 7, bases have a pH of greater than 7, and a neutral solution has a pH equal to 7. The stronger the acid, the lower the pH. The stronger the base, the higher the pH.

SUGGESTED LEARNING RESOURCES

Science 10

8.1 Investigation: Recognizing Acids and Bases

8.2 Properties of Acids and Bases

8.3 The pH Scale

BLM 2.7a The pH Scale

BLM 8.1 Natural Acid/Base Indicators: How They Work

BLM 8.2 Different Kinds of Acids and Bases

BLM 8.5 Making Acids and Bases

Science Power 10

7.1 Common Acids and Bases

Investigation 7-A: Acid or Base?

7.2 pH: A Powerful Scale

7.3 The Properties of Acids and Bases

Investigation 7-D: Chemical Properties of Acids

BLM 7-1 Making a "Chemystery" Message

BLM 7-2 A Matter of Taste

BLM 7-3 Acid or Base Pre-Test

BLM 7-6 Identifying Acids and Bases in Chemical Equations

BLM 7-7 Know Your Indicators

BLM 7-8 Identifying Acids and Bases

BLM 7-9 pH Scale

BLM 7-10 The pH of Common Acids and Bases

BLM 7-18 Measuring the pH of Water Samples

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-08 Experiment to classify acids and bases using their characteristic properties.

Include: indicators, pH, reactivity with metals

GLO: D3, E1

SUGGESTIONS FOR INSTRUCTION

(2 HOURS)

Laboratory Activity S2-0-3a, 4a, 4b, 9c

Students experiment to identify substances as acids or bases using their characteristic physical and chemical properties. See Appendix 2.3: Experiment: Properties of Acids and Bases.

Journal Writing S2-0-2c

Students compare and contrast the characteristic properties of acids and bases. A Compare and Contrast or Concept Relationship frame may be used (see *SYSTH* 10.24, 11.21).

Suggestions for Assessment

Suggested Learning Resources

SYSTH

3.15 Rotational Cooperative Graffiti

10.24 Compare and Contrast

11.21 Concept Relationship

13.21 Journal Evaluation

14.12 Lab Report

Appendices

2.3 Experiment: Acids and Bases

6.4 Lab Report Assessment

Prescribed Learning Outcomes
Students will...
S2-2-09 Discuss the occurrence of acids and bases in biological systems, industrial processes, and domestic applications. Include: safety and health considerations GLO: B2, B3, C1, C8

Suggestions for Instruction
(3 hours)

➢ Notes for Instruction

There are many examples that can be used to illustrate systems, processes, and applications of acid/base chemistry, but the reactions are often quite complex. Limit the discussion to the occurrence and role of acids and bases in various settings.

➢ Student Learning Activities

Laboratory Activity S2-0-1a, 3c, 4b, 4d

Students investigate the occurrence and role of acids and bases. Possible laboratory activities may include
- testing the effectiveness of antacids
- preparing soap
- determining the pH of household products

Student Research S2-0-1b, 2b, 4d, 8g

Students or student groups research the occurrence of acids and bases in biological systems, industrial processes, and domestic applications. Examples may include
- antacids
- detergents
- citrus fruits
- household cleaning products
- industrial catalysts
- digestion of food
- fertilizers
- baking powder
- construction (mortar, plaster)

Safety and health considerations should be included.

Case studies, current newspaper articles, and Internet sources can be used.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-5c, 6a, 7a, 7b

Students interpret their laboratory results and prepare a report of their investigation findings (see *SYSTH* for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Research Report/Presentation S2-0-2c, 4c, 8e, 9a

Students or student groups prepare and present their research of the occurrence of acids and bases with

- written reports
- oral presentations
- multimedia presentations
- newspaper articles
- dramatic presentations
- brochures
- pamphlets

Teacher Background

Examples of acids and bases in biological systems include

- stomach acid (hydrochloric acid)
- bee and wasp stings (formic acid)
- pancreatic fluid (includes sodium bicarbonate)
- citrus fruit (citric acid)

Examples of acids and bases in industrial processes include

- explosives (nitric acid)
- fertilizers (ammonia)
- glass etching (hydrofluoric acid)
- speeding up industrial chemical reactions (sulfuric acid)

Examples of acids and bases in domestic applications include:

- window cleaner (ammonia)
- drain cleaner (sodium hydroxide)
- antacids (calcium hydroxide)
- pickles (acetic acid)

(continued)

Suggested Learning Resources

Science 10

8.4 Investigation: Household Products and pH

8.11 Investigation: Testing Antacids

8.12 Case Study: Putting It All Together: Acids and Bases in Industry

BLM 8.4a pH of Household Products

ABLM 8.2 WHMIS Symbols for Acids and Bases

ABLM 8.4 Investigating Household Products and pH

Science Power 10

8.2 Chemicals for Consumers

Investigation 8-C: Testing the Effectiveness of Antacids

BLM 7-15 Daily Applications of Acids, Bases, and Salts

BLM 7-17 Swimming-Pool Chemistry

BLM 8-6 Analyzing Antacids

BLM 8-7 Testing the Effectiveness of Antacids

BLM 8-8 Antacid Calculations

BLM 8-9 Water, Soaps, and Detergents

BLM 8-10 Comparing Soaps and Detergents

BLM 8-20 Uses of Sulfuric Acid in Industry

SYSTH

3.20 Jigsaw

13.21 Journal Evaluation

14.12 Lab Report Format

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-2-09 Discuss the occurrence of acids and bases in biological systems, industrial processes, and domestic applications.

Include: safety and health considerations

GLO: B2, B3, C1, C8

SUGGESTIONS FOR INSTRUCTION

(3 HOURS)

Visual Display S2-0-1d, 2c, 4c, 4f

Student groups construct visual displays of acids and bases in their homes. Health and safety considerations should be included. Examples may include

- baking soda
- soap
- vinegar
- window cleaner
- pickles
- swimming pool chemicals (muriatic acid)

Collaborative Teamwork S2-0-1c, 2a, 9b, 9c

Various student groups investigate examples of the occurrence of acids and bases, and share their findings with their classmates in a Jigsaw format (see *SYSTH* 3.20).

Journal Writing S2-0-7f

Students reflect on and respond to the following questions:

- How has your understanding of acids and bases changed since the start of the cluster?
- What new questions do you have about acids and bases?
- What new information in this cluster surprised you?

SUGGESTIONS FOR ASSESSMENT

Visual Display S2-0-5c, 8f, 9b, 9f

Student groups present visual displays of acids and bases used in their homes. Displays may take the form of

- posters
- bulletin board presentations
- dioramas
- charts

Journal Writing S2-0-7f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- identify WHMIS symbols for acids and bases
- explain why antacids are used to treat heartburn
- differentiate between soap and detergent
- discuss the role of sulfuric acid as a catalyst in industry
- explain why citrus fruits and pickles taste sour
- discuss why acids are always added to water when preparing solutions as a safety precaution
- describe the function of baking soda in baking
- identify basic cleaning products used in the home
- suggest safe storage tips for household cleaning products
- explain why one should always wash one's hands after using products such as drain cleaner or bleach
- describe first-aid treatment for accidental ingestion of cleaning products

SUGGESTED LEARNING RESOURCES

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

Prescribed Learning Outcomes
Students will...
S2-2-10 Explain how acids and bases interact to form a salt and water in the process of neutralization. GLO: D3, E2

Suggestions for Instruction

(1 hour)

➢ Notes for Instruction

Activate student knowledge and note misconceptions. Students will have heard the terms *neutralize*, *salt*, and *neutralization*, but may not be aware of the scientific use of the terms.

Discuss neutralization as a double displacement reaction producing a salt and water. Use halogen acids (e.g., hydrochloric acid) and alkali metal bases (e.g., sodium hydroxide) as examples.

For example, $HCl + NaOH \rightarrow H_2O + NaCl$.

Bronsted-Lowry and related advanced definitions of acid-base relationships should be expressly avoided in Senior 2. These aspects will be addressed in detail in Senior Years chemistry courses.

➢ Student Learning Activities

Laboratory Activity/Teacher Demonstration
S2-0-1a, 3a, 4a, 4d

Pose the question, "What happens when an acid and a base are mixed together?"

Add a few drops of universal indicator to an acid solution and to a base solution. Students observe the different indicator colours and therefore different pHs of the two solutions.

Add acid solution drop by drop to the base solution until the neutral point is reached. Students observe colour changes the base solution undergoes as it approaches the neutral point.

Repeat the procedure adding base solution drop by drop to the acid solution. Ask students to suggest an explanation for the observed colour changes. CBLs or MBLs equipped with pH metre and real-time graphing software can also be used.

Journal Writing S2-0-2c, 8b

Students complete a Word Cycle of the following acid-base related terms: *salt, pH, acid, neutralization, indicator, base, water, neutral,* and *reaction* (see *SYSTH* 10.21).

Collaborative Teamwork S2-0-4f

Student groups balance acid-base neutralization reactions. Complex reactions such as $H_2SO_4 + Al(OH)_3 \rightarrow H_2O + Al_2(SO_4)_3$ should be avoided.

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-4b, 6a, 7a,

Students interpret their laboratory results and prepare a report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Journal Writing S2-0-2c, 8b

Assess journal entries with a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- define the terms *neutralization* and *salt*
- write balanced chemical equations for neutralization reactions
- explain why a salt and water form in a neutralization reaction
- discuss why a neutralization reaction is classified as a double displacement reaction
- complete a Word Cycle of the following terms: *salt, pH, acid, neutralization, indicator, base, water, neutral,* and *reaction* (see *SYSTH* 10.21)
- explain the importance of using precise language in science

Teacher Background

Salt is commonly thought of as sodium chloride or NaCl. In the language of chemistry, however, a salt is defined as an ionic solid consisting of a positive ion other than hydrogen, and a negative ion other than hydroxide.

Suggested Learning Resources

Science 10

8.9 Investigation: Reacting Acids and Bases

8.10 Neutralization Reactions

Science Power 10

7.4 Neutralization Reactions

Investigation 7-E: Drop-by-Drop Neutralization

BLM 7-5 Cracking the Chemistry Code

SYSTH

10.21 Word Cycle

13.21 Journal Evaluation

14.12 Lab Report

Appendix

6.4 Lab Report Assessment

Prescribed Learning Outcomes

Students will...

S2-2-11 Describe the formation and environmental impact of various forms of air pollution.

Examples: acid precipitation, ground-level ozone, air-borne particulates, smog, ozone depletion, respiratory ailments, and acidified lakes…

GLO: B5, C6, D2, D5

Suggestions for Instruction

(3 hours)

➢ Entry-Level Knowledge

In Grade 5, students explained how human health may be affected by natural- and human-caused environmental factors. In Grade 7, students examined the potential harmful effects of some substances on the environment. In Grade 8, the hydrological cycle and water pollution were studied. Students will have heard the terms *acid rain*, *smog*, and *ozone*.

➢ Notes for Instruction

A Listen-Draw-Pair-Share or KWL activity can be used to activate prior knowledge of the learning outcome (see *SYSTH* 9.15, 9.25). Take advantage of current information available in print and electronic media. Environment Canada's Science and the Environment Bulletin <www.ec.gc.ca/science/splash.htm>, Envirozine <www.ec.gc.ca/envirozine/english/home_e.cfm>, and Meteorological Services, <www.msc-smc.ec.gc.ca/contents_e.html> contain up-to-date information.

While the term acid rain is most frequently used, acidic precipitation can also occur in the form of snow or sleet. Use chemical equations to illustrate the formation of acid rain. Distinguish between normal rain (pH of 5.5–6.2) and acid rain (pH < 5.0).

Distinguish between harmful ground-level ozone, which damages plants, lungs, and materials such as rubber and paint, and beneficial upper-level (stratosphere) ozone, which provides protection from ultraviolet radiation.

Describe how smog is produced, and explain why it tends to be a problem in summer, rather than in the winter. Explain that air-borne particulates can come from a variety of sources such as dust, pollen, smoke, and industrial and automobile emissions.

➢ Student Learning Activities

Visual Display/Collaborative Teamwork S2-0-1c, 2a, 4f, 4g

Student groups create displays illustrating the formation of various forms of air pollution. Some examples may include

- acid precipitation
- ground-level ozone
- smog

Case studies, newspaper articles, and Internet sources can be used.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2b, 8a, 9b, 9c

Student groups present visual displays of various forms of air pollution with

- posters
- bulletin board presentations
- charts
- cartoons
- dioramas

Laboratory Report S2-0-5a, 6a, 7a, 7b

Students interpret their results and prepare reports of their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Teacher Background

The burning of coal in electric power plants is a major source of sulfur oxide emissions. The sulfur oxides combine with water in the atmosphere and form sulfuric and sulfurous acid. Automobile engines are a major source of nitrogen oxide emissions. The nitrogen oxides combine with water in the atmosphere and form nitric and nitrous acids.

Photochemical smog continues to be a growing problem in both developed and developing nations. Smog forms when nitrogen oxides and unburned hydrocarbons (primarily from automobile engines) react in the presence of UV light to form ozone and toxic organic compounds (including PAN). The brownish haze can cause eye and lung irritation, damage or kill plants, and deteriorate materials such as rubber, paint, and nylon. The term "smog" is derived from the words *smoke* and *fog*.

(continued)

Suggested Learning Resources

Science 10

3.11 Acid Deposition and Forest Ecosystems

3.12 Investigation: Assessing the Effects of Acid Rain

6.14 Explore an Issue: Is Pollution Necessary?

7.8 Debate: The Sale and Use of Cars Should Be Restricted

8.7 Case Study: Air Pollution and Acid Precipitation

8.8 Investigation: Acid Precipitation and Buildings

Unit 2 Challenge: Chemical Processes and Society

16.2 The Greenhouse Effect and Ozone Depletion

16.4 Observing Pollution

BLM 3.11 Formation of Acid Rain

ABLM 3.11 KWL-Acid Precipitation

ABLM 3.12 The Effects of Acid Rain

ABLM 7.8 Restricting the Production of New Cars

ABLM 16.5 Smog Alert!

Science Power 10

Investigation 2-D: An Acid Test

8.3 Chemicals and our Environment

Unit 2 Issue Analysis: Not in My Backyard Acid Precipitation Resource

16.5 Past, Present, and Future

BLM 2-14 An Acid Test

BLM 4-3 Environments in Distress

BLM 8-11 Acid Rain and Its Effects

(continued)

Prescribed Learning Outcomes

Students will...

(continued)

S2-2-11 Describe the formation and environmental impact of various forms of air pollution.

Examples: acid precipitation, ground-level ozone, air-borne particulates, smog, ozone depletion, respiratory ailments, and acidified lakes…

GLO: B5, C6, D2, D5

Suggestions for Instruction

(3 hours)

Laboratory Activity S2-0-1b, 3c, 4a, 4b

Students experiment to determine the impact(s) of acid precipitation on

- germinating seedlings
- marble monuments
- limestone buildings
- growth of yeast populations

Student Research S2-0-1d, 2b, 8g, 9e

Students or student groups research ways various forms of air pollution affect the environment, explaining the impact of

- acid rain on stone buildings and monuments
- air-borne particulates on the human respiratory system (e.g., asthma)
- ground-level ozone on plants
- ultraviolet radiation on human skin

Case studies, newspaper articles, and Internet sources can be used.

Journal Writing S2-0-2d, 3d, 6d, 7d

Students complete a creative writing assignment using a RAFTS format. They may be presented with scenarios such as the following:

- As a fish, write an editorial in *The Aquatic Times*, complaining about acid rain to the other lake residents.
- As a tree, write a letter to the editor of a newspaper, raising your concerns about air quality.

Suggestions for Assessment

Research Report/Presentation S2-0-8a, 8c, 8g, 9e

Students or student groups prepare and present their research findings with

- written reports
- oral presentations
- brochures
- pamphlets
- newspaper articles
- multimedia presentations

Journal Writing S2-0-7e, 9d, 9e, 9f

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- write balanced chemical equations for the formation of acid rain
- distinguish normal rain from acid rain in terms of pH
- identify sources of sulfur oxide and nitrogen oxide emissions
- describe the effects of acid rain on lakes
- predict the economic impact of acid rain on the tourism industry
- describe the formation of smog
- suggest reasons why vigorous outdoor exercise is not advisable during a smog alert
- differentiate between ground-level ozone and upper-level ozone
- discuss the impact of CFCs on upper-level ozone
- describe the UV Index
- explain how sunscreens protect skin against UV radiation
- identify sources of air-borne particulates
- explain why people with respiratory ailments may be especially sensitive to air-borne particulates
- write balanced chemical equations for the combustion of fossil fuels such as methane (CH_4), gasoline (C_8H_{18}), and alcohols such as ethanol (CH_3CH_2OH)

Suggested Learning Resources

BLM 8-12 The Effects of Sulfur and Nitrogen Oxides

BLM 16-9 The Ozone Layer

BLM 16-10 CFCs: For or Against?

SYSTH

9.15 Listen-Draw-Pair-Share

9.17 KWL Plus

13.21 Journal Evaluation

13.22 RAFTS

14.12 Lab Report Format

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

Prescribed Learning Outcomes
Students will...
S2-2-12 Investigate technologies that are used to reduce emissions of potential air pollutants. *Examples: catalytic converters in automobiles, regulation of vehicle emissions, elimination of CFCs from refrigerants and aerosol propellants…* GLO: A5, B5, C8, E2

Teacher Background

Tougher standards in North America have reduced emissions of acid-rain-forming compounds. As a result, acid rain has significantly decreased in the past decade. This is not the case in many developing nations in which emissions standards are low or non-existent.

Suggestions for Instruction
(3 hours)

➢ Entry-Level Knowledge

In Grade 8, students identified ways of reducing or eliminating the effects of water pollution.

➢ Notes for Instruction

A Listen-Draw-Pair-Share or KWL activity can be used to activate prior knowledge of the learning outcome (see *SYSTH* 9.15, 9.25). Take advantage of current information in print and electronic publications. Be sure to include the perspectives of various stakeholders in an exploration of the issues.

➢ Student Learning Activities

Student Research S2-0-1c, 2d, 8d, 9e

Students or student groups investigate technologies that could be used to reduce emissions of potential air pollutants. Examples include

- using catalytic converters in automobiles
- burning low-sulfur coal in power plants
- mandatory emissions testing of all cars and trucks
- alternatives to using CFCs in refrigerators and air conditioners

Case studies, newspaper articles, and Internet sources may be used.

Debate S2-0-1c, 2d, 3d, 3e

Older models of cars and trucks are responsible for the greatest per capita amount of automobile exhaust pollutants being released into the atmosphere. Students debate whether older vehicles should undergo emissions testing, and whether those that fail should be removed from the road.

Visual Display/Collaborative Teamwork S2-0-1b, 4g, 8c, 8d

Student groups create visual displays illustrating technologies that could be used to reduce emissions of potential air pollutants. Examples include

- scrubbing of waste gases in smokestacks
- alternatives to using CFCs in aerosol propellants
- using gasohol as fuel in automobile engines

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Journal Writing S2-0-2d, 3f, 7d, 7e,

Discuss the outcome of the debate. Ask students to summarize the arguments presented by both teams and to reflect on any new information they gained from the debate in their journals. Assess journal entries with a Journal Evaluation form (see *SYSTH* 13.21).

Visual Display S2-0-9b, 9c, 9d

Student groups present visual displays illustrating technologies that could be used to reduce emissions of potential air pollutants with

- posters
- bulletin board presentations
- dioramas
- models
- charts

Pencil-and-Paper Tasks

Students

- suggest ways they can change their transportation habits to reduce automobile emissions
- discuss technologies that could be used to reduce oxides of sulfur emissions
- describe the purpose and structure of a catalytic converter
- explain the significance of the Montreal Protocol
- formulate a rationale for the removal of sulfur from hydrocarbon fuels
- differentiate between gasoline and gasohol

Research Report/Presentation S2-0-7a, 7b, 8g, 9e

Students and student groups present

- written reports
- oral presentations
- brochures
- pamphlets
- multimedia presentations

Suggested Learning Resources

Science 10

6.14 Explore an Issue: Is Pollution Necessary?

7.8 Rates and Automobiles

8.7 Case Study: Air Pollution and Acid Precipitation

Unit 2 Challenge: Chemical Processes and Society

16.2 The Greenhouse Effect and Ozone Depletion

BLM 3.12b Sudbury: A Reclamation Success Story

BLM 7.8 Catalytic Converters—Reduce Automobile Pollution, But…

Science Power 10

8.3 Chemicals and our Environment

Unit 2 Issue Analysis: Not in My Backyard Acid Precipitation Resource

16.4 Past, Present, and Future

BLM G-29 Scientific Research Planner

BLM G-30 Research Worksheet

BLM G-31 Internet Research Tips

SYSTH

9.15 Listen-Draw-Pair-Share

9.17 KWL Plus

13.21 Journal Evaluation

Appendices

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

NOTES