Science

Science Grade 12

Curriculum Map

Topic B: Chemistry and the Environment

Resources Included: *Academic One File, Global Issues in Context, Histor!ca The Canadian Encyclopedia, Science in Context*

Betty-Lou Ayers
On Behalf of THE ALBERTA LIBRARY
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User Guide

Curricular Topic

(taken from Alberta Education's Program of Studies)

If you have any questions regarding this guide or if you would like a guide for additional grades please contact Bethany Arsenault, ORC Coordinator at barsenault@thealbertalibrary.ab.ca

Topic B: Chemistry and the Environment

Themes
Change, Energy, Systems

Overview
In maintaining quality of life, society is becoming increasingly reliant upon chemical substances of life. These chemicals and their by-products can also adversely affect the environment and living systems. A knowledge of chemistry is essential to fully understand the benefits and risks of chemicals to humankind and in monitoring the emission of these substances into the environment. In this unit, students examine the impacts of acids and bases, organic compounds and air pollutants on aquatic and terrestrial ecosystems.

Focusing Questions
What are some of the important effects of acids, bases and synthetic organic compounds on the environment and living systems? What are the chemical principles and perspectives involved in the assessment of the technologies designed to reduce the production and emission of these compounds into the environment? How does society look beyond a technological fix in deciding how to best meet human needs while sustaining the environment?

General Outcomes: There are three major outcomes in this unit.
Students will:

- analyze the sources of acids and bases and their effects on the environment
- analyze the sources of organic compounds and their effects on the environment
- analyze, from a variety of perspectives, the risks and benefits of using chemical processes in meeting human needs and assess technologies for reducing the impact of chemical compounds on the environment.

General Outcome 1

***Students will* analyze the sources of acids and bases and their effects on the environment.**

Specific Outcomes for Knowledge
Students will:

- define acids and bases in terms of proton donors and proton acceptors
- differentiate among acids, bases, neutral ionic compounds, neutral molecular compounds and strong and weak acids, based on appropriate diagnostic tests
- describe the relationship between pH and hydronium ion concentration
- explain, qualitatively, how buffers maintain a relatively constant pH when a small amount of acid or base is added to an aqueous system
- explain the importance of maintaining a relatively constant pH in a living system; *e.g., the role of the hydrogen carbonate ion in maintaining the pH of blood, the evolution of the Arctic herb Artemisia tilesii in resisting acidic moisture by extracting calcium from the soil and pumping the calcium to its leaves*
- trace the historical use of acid-base indicators; *e.g., early Aboriginal methods of using extracts from natural substances*
- explain what is meant by buffering capacity; *e.g., soil or bedrock*
- outline the chemical reactions (*e.g., combustion reactions*) that produce air pollutants (i.e., sulfur dioxide and nitrous oxides) that, when combined with water, ultimately result in acid deposition
- describe impacts on the biotic and abiotic components of the environment caused by acid deposition; *e.g., lowered pH in water systems, accelerated corrosion, metal leaching from bedrock, the impact of leached metals on plants and the food chain*.

Specific Outcomes for Science, Technology and Society (STS)

Students will:

- demonstrate an understanding that science and technology developed to meet societal needs and expand human capacity
- describe, in general terms, the uses of acids and bases in industry; *e.g., hydrochloric acid used to extract metals from ores; sulfuric acid used to make fertilizers, paints, plastics, dyes and detergents; and sodium hydroxide used to make soaps and*

drain and oven cleaners
- explain how science and technology have both intended and unintended consequences for humans and the environment
- identify and explain how human activities and natural events contribute to acid deposition in the environment.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will: formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- design a procedure to identify acidic, basic, neutral ionic and molecular solutions
- design an experiment for determining the buffering capacity of local soil or pond samples

Performing and Recording

Students will: conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information

- use a pH meter and/or pH paper and indicators to measure the pH of solutions; *e.g., collect pH data to study an aquatic ecosystem*
- use indicators and a conductivity meter to differentiate between a strong acid and a weak acid
- perform a titration using a strong monoprotic acid and a strong monoprotic base
- use computer-based probes and/or a graphing calculator to measure the pH of water and/or aqueous solutions

Analyzing and Interpreting

Students will: analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- use titration data to determine the concentration of a strong acid or a strong base
- research and plot on a map the distribution patterns of acid deposition as influenced by prevailing winds
- calculate pH from hydronium ion concentration and hydronium ion concentration from pH
- calculate the concentration of strong monoprotic acids and strong monoprotic bases from empirical data

Communication and Teamwork
Students will: work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- compare collected titration data with that of other individuals and groups
- use appropriate scientific conventions when communicating solutions to titration problems
- research protocols for transporting acidic and caustic materials through populated *areas*
- prepare a group visual display explaining initiatives taken by industry to reduce *emissions that can cause acid deposition*

General Outcome 2

Students will **analyze the sources of organic compounds and their effects on the environment.**

Specific Outcomes for Knowledge
Students will:

- identify and name carbon compounds, using International Union of Pure and Applied Chemistry (IUPAC) nomenclature that contain up to three carbon atoms in the parent chain and a single occurrence of one type of functional group, including simple halogenated hydrocarbons *(e.g., 2-chloropropane)*, alcohols *(e.g., propan-1-ol)*, carboxylic acids *(e.g., propanoic acid)* and esters *(e.g., methyl propanoate)*
- describe the common uses of hydrocarbons, including simple halogenated hydrocarbons, alcohols, carboxylic acids and esters; *e.g., chlorofluorocarbons (CFCs) as refrigerants, as propellants and in the manufacture of plastic foam products; ethanol as a solvent and as a gasoline additive; ethanoic acid as vinegar; ethyl ethanoate as nail-polish remover*
- identify organic compounds commonly considered to be environmental pollutants; i.e., hydrocarbons, organic waste, CFCs, polychlorinated biphenyls (PCBs), dioxins and furans
- list the sources of, and analyze the hazards posed by, halogenated hydrocarbons and benzene derivatives
- identify and explain how human activities and natural events contribute to the production of photochemical smog, the depletion of the ozone layer and increased concentrations of

organic compounds in the environment; *e.g., driving a car, use of CFCs, agricultural practices*
- explain the mechanism and significance of biomagnification.

Specific Outcomes for Science, Technology and Society (STS)

Students will:

- explain how science and technology have both intended and unintended consequences for humans and the environment
- explain how the introduction of environmental contaminants, i.e., herbicides, pesticides, dichlorodiphenyltrichloroethane (DDT), CFCs, SO2(g), CO2(g), particularly persistent organic pollutants (POPs), affects living systems globally
- interpret information describing biomagnification and environmental persistence of organic pollutants on biological systems; *e.g., lethal dose (LD, LD 50), PCBs, DDT*.

Specific Outcomes for Skills

Students will:

- formulate questions about observed relationships and plan investigations of questions, ideas, problems and issue
- design an investigation of alternatives to the use of pesticides or herbicides
- predict the impact of synthetic organic compounds on a local aquatic or terrestrial ecosystem

Performing and Recording

Students will: conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information

- *search and record initiatives designed to reduce the impact of halogenated hydrocarbons on the environment*
- *investigate the action of a pesticide or herbicide, considering toxicity, volatility, target specificity and resistance development*
- *prepare a synthetic organic compound (e.g., an alcohol, an ester or a soap) and investigate its properties*

Analyzing and Interpreting

Students will: analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- use current reliable information sources to analyze technologies used to reduce the release of POPs into the environment

Communication and Teamwork
Students will: work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- develop a plan to study the impact of organic compounds on an aquatic or a terrestrial *ecosystem and make revisions, based on group feedback, before implementing the plan*

General Outcome 3

Students will **analyze, from a variety of perspectives, the risks and benefits of using chemical processes in meeting human needs and assess technologies for reducing the impact of chemical compounds on the environment.**

Specific Outcomes for Knowledge
Students will:

- describe the risks and benefits of using chemical processes that may produce products and/or by-products that have the potential to harm the environment*)*
- describe technologies used to reduce the production and emission of chemical compounds that have the potential to harm the environment; *e.g., activities related to internal combustion engines, smelting, pesticide production, sweetening of sour gas*
- describe alternatives to the use of chemical technologies; e.g. bioremediation for contaminated soil, biological controls for pests, biodegradable products.

Specific Outcomes for Science, Technology and Society (STS)

Students will: explain how science and technology have both intended and unintended consequences for humans and the environment

- explain the role of concentration in a risk-benefit analysis for determining the safe limits of particular substances; *e.g., pesticide residues, chlorinated or fluorinated compounds*

explain that the appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability

- explain the meaning of technological fix and explain the need for broader considerations in reducing the environmental impact of the by-products of chemical processes.

Specific Outcomes for Skills

Initiating and Planning

Students will: formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- plan an evaluation, including a risk-benefit analysis, of a chemical process or an issue related to its use
- describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with references to WHMIS and consumer product labelling information
- hypothesize about seasonal variations in water quality in the community

Performing and Recording

Students will: conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information

- debate the issue of whether protecting the environment should have priority over economic interests
- collect information from a wide selection of resources relating to a chemical process or an issue related to its use

Analyzing and Interpreting

Students will: analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- interpret data from water quality tests, such as pH, BOD, dissolved oxygen and organic compounds
- analyze alternatives to the use of chemical technologies; e.g., bioremediation for contaminated soil, biological controls for pests, biodegradable products
- evaluate methods used to reduce the incidence of acid deposition and photochemical smog; e.g., reducing sulfur content in fuels, using catalytic converters in automobiles, smokestack scrubbers
- present statistical data in diagrams, tables and graphs as part of a briefing for a public hearing on a proposed chemical industry in an ecologically sensitive area

Communication and Teamwork

Students will: work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- consult and evaluate a wide variety of sources that reflect varied viewpoints on the risks and benefits of using particular chemicals*; e.g., the use of DDT in countries where malaria is a major cause of death*

General Outcome 1:

***Students will* analyze the sources of acids and bases and their effects on the environment.**

Section 1: General Topic Reference

Acid Rain: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Acids and Bases: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Atmospheric Chemistry: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Section 2: Reference

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Section 3: Experiments

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Section 4: Video

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Section 5: Websites

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General Outcome 2:

***Students will* analyze the sources of organic compounds and their effects on the environment.**

General Outcome 3:

***Students will* analyze, from a variety of perspectives, the risks and benefits of using chemical processes in meeting human needs and assess technologies for reducing the impact of chemical compounds on the environment.**

Section 7: General Topic Reference

Air Pollution: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

DDT: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Ecological Pyramids: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Hydrocarbons: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Ozone: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Ozone Layer Depletion: *Global Issues in Context:* Topic/definition page contains subject overview, global viewpoints primary sources, podcasts, reference, magazine and news articles, statistics, and websites.

Plastics: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Section 8: Audio

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Section 11: Articles

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"Predictors Of Plasma DDT And DDE Concentrations Among Women Exposed To Indoor Residual Spraying For Malaria Control In The South African Study Of Women And Babies (SOWB)." *Environmental Health Perspectives* 122.6 (2014): 545. *Academic One File*. Web. 29 Aug. 2017.

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Section 12: Videos

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Section 13: Images

"Biomagnification of the pesticide DDT in the food chain." *Environmental Encyclopedia*. Ed. Marci Bortman, Peter Brimblecombe, and Mary Ann Cunningham. 3rd ed. Detroit: Gale, 2011. *Science in Context*. Web. 15 Sept. 2015.

"DDT Dichlorodiphenyltrichloroethane." *World of Biology*. Gale, 1999. *Science in Context*. Web. 15 Sept. 2015. Clutch of mallard eggs contaminated by DDT. The accumulation of DDT in many birds causes reproductive difficulties. Eggs have thinner shells that break easily, and some eggs may not hatch at all.