DOCUMENT RESUME

ED 352 258 SE 053 251

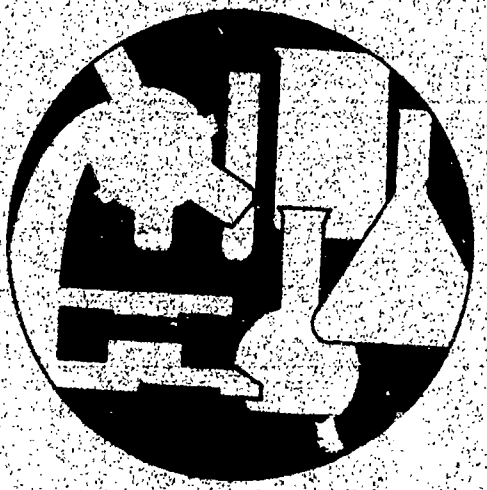
TITLE	Science 10: Teacher Resource Manual, 1992 (Interim).
INSTITUTION	Alberta Dept. of Education, Edmonton. Communications Branch.
PUB DATE	92
NOTE	219p.; For the senior high science teacher resource manual, see SE 053 250.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC09 Plus Postage.
DESCRIPTORS	Concept Formation; Concept Teaching; Cooperative Learning; Educational Resources; Foreign Countries; Grade 10; High Schools; Integrated Activities; Integrated Curriculum; *Interdisciplinary Approach; *Learning Processes; *Learning Theories; *Library Research; Science and Society; *Science Curriculum; *Science Education; Science Instruction; Secondary School Science; Teaching Methods
IDENTIFIERS	Alberta; Science Process Skills

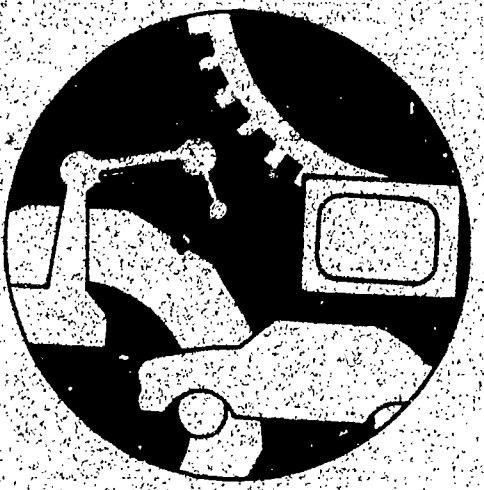
ABSTRACT

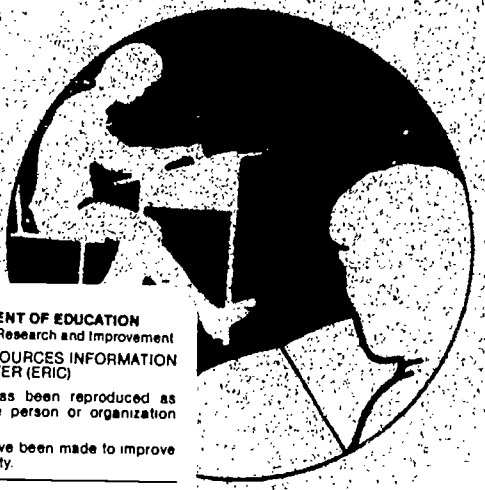
This manual is designed to provide teachers with practical information to assist them as they implement the Science 10 program in their classrooms. The introduction of the Science 10 program in Alberta provides an opportunity for teachers to move out of their particular discipline of expertise and explore with their students the larger area of science. Themes for this integrative approach come from the science content, from the nature of the science,and from the interactions of science with technology and society. Sections in this book include the following: "Learning Cycle Exemplars by Unit," "Concept Connections," "Cooperative Learning Activities," "Library Research in Science 10," and "Resources." Learning cycle lesson exemplars pertain to the following units: Energy from the Sun, Matter and Energy in Living Systems, Matter and Energy in Chemical Change, and Energy and Matter. (PR)

SCIENCE 10

Teacher Resource Manual







1992 (Interim)

Curriculum Branch

Alberta EDUCATION

ACKNOWLEDGEMENTS

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Validators

Senior High Science Field Validation Teachers (approximately 100 teachers)

TABLE OF CONTENTS

PREFACE

The *Science 10 Teacher Resource Manual* is designed to provide teachers with practical information to assist them as they implement the Science 10 program in their classrooms. The teaching and evaluation strategies in this teacher resource manual are **suggestions** only and are not mandated. The Course of Studies for Science 10 outlines what teachers are **required** to teach.

Portions taken directly from the Science 10 Course of Studies will appear in boxes surrounded by a broken line - - - - within this draft Teacher Resource Manual. A senior high science teacher will find it useful to have both the *Senior High Science Teacher Resource Manual* and the *Science 10 Teacher Resource Manual*. The two are designed to work together, avoiding repetition of material common to all science programs.

The following teacher resource manuals support the senior high science curricula.

Science 16-26 Teacher Resource Manual (Final)

Science 14–24 Teacher Resource Manual, 1989 (Final)

Senior High Science Teacher Resource Manual,
June 1992 (Interim)
June 1994 (Final)

Science 10 Teacher Resource Manual, June 1992 (Interim)
Science 20 Teacher Resource Manual, June 1993 (Interim),
Science 10–20–30 Teacher Resource Manual, June 1994 (Final)

Biology 20 Teacher Resource Manual, June 1993 (Interim)
Biology 20–30 Teacher Resource Manual, June 1994 (Final)

Chemistry 20 Teacher Resource Manual, June 1993 (Interim), *Chemistry 20–30 Teacher Resource Manual*, June 1994 (Final)

Physics 20 Teacher Resource Manual, June 1993 (Interim), *Physics 20–30 Teacher Resource Manual*, June 1994 (Final)

All manuals will be divided into sections with each section paginated separately. This facilitates the revision and rearrangement of the interim documents.

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BACKGROUND TO THE SCIENCE 10 PROGRAM

by Dr. Oliver Lantz

AN INTEGRATED SCIENCE CURRICULUM

An integrated curriculum is one that gives both the knowledge of existing frameworks and the desire and power to create new ones.

In an integrated approach to science education, discipline boundaries are viewed as artificial human constructs and the fundamental unity of scientific thought is emphasized by organizing the science curriculum around themes (e.g., major concepts, science processes, persistent problems or issues) that transcend traditional science discipline boundaries. The integrated approach has two main goals—to provide learners with a framework that nurtures meaningful organization of unstructured facts, and to develop the learners' ability to perceive and create new structures for themselves. An integrated curriculum is one that gives both the knowledge of existing frameworks and the desire and power to create new ones.

Interest in integrated science education has resulted from the realization that an integrated approach more accurately reflects the nature of science and has considerable educational value. The blurring of boundaries between traditional sciences is illustrated by the current expansion of science knowledge where major advances in scientific research are now taking place in interdisciplinary areas such as geophysics, astrophysics and biochemistry. An integrated science curriculum reflects science, as it is known by modern scientists, better than a discipline-oriented science curriculum. Curriculum studies indicate that integrated science contributes to development of scientific literacy and student understanding of the social aspects of science.

The development of the integrated science approach is motivated by the belief that there exists a fundamental unity of thought in the enterprise of science and that this should be reflected in the science curriculum; that is, the study of science may vary in direction but not in methodology, because the fundamental concepts, skills and attitudes of science are common to all areas of investigation.

The introduction of the Science 10–20–30 program in Alberta provides an opportunity for teachers to move out of their particular discipline of expertise and explore with their students the larger field of science. This will not be as difficult as many teachers imagine, if the focus is placed on the themes that are common in all areas of science. To take advantage of the opportunities provided by an integrated

science approach, themes that integrate the units of the Science 10–20–30 program need to be emphasized. The integrative themes come from the science content, from the nature of the science, and from the interactions of science with technology and society.

The Science 10–20–30 program emphasizes major concepts, scientific process skills and scientific attitudes, which provide common threads that run through all units of study. The big ideas of science (e.g., matter, energy, systems) are the conceptual foundations that link the theoretical structures of various scientific disciplines. These conceptual foundations provide a means of showing the connections among the scientific disciplines. Conceptual foundations provide a framework for teachers to show students how parts of what they are learning fit together logically, and to focus on the big ideas of science rather than memorization of seemingly isolated facts, and to ensure that fundamental concepts are covered in a science program. They can be used to link facts, theories and ideas that occur repeatedly within a unit, from one unit to another and from one course to another, and to communicate these links explicitly.

Conceptual foundations provide a framework for teachers to show students how parts of what they are learning fit together logically, and to focus on the big ideas of science rather than memorization of seemingly isolated facts.

The scientific skills and attitudes developed in Science 10–20–30 provide additional integrative themes. The scientific process skills which are common to all parts of the science curriculum include questioning; proposing ideas; designing experiments; and gathering, processing, and interpreting evidence. By illustrating that the processes of scientific investigation are similar despite the particular discipline framework, the unified nature of the scientific enterprise is emphasized. Similarly, emphasis on the positive scientific attitudes of critical-mindedness, suspended judgment, respect for evidence, honesty, objectivity, willingness to change, open-mindedness and a questioning attitude, are threads that run through the entire science curriculum.

The context in which the science material is presented also provides a means of integrating the Science 10–20–30 program. A nature of science context provides an opportunity to illustrate how scientific knowledge is developed. For example, the role of empirical evidence in developing and revising theories is the same whether the content is biology, chemistry, physics or earth science. Similarly, common elements emerge when the interactions of science and technology, and the role of science and technology in societal decision making are used as the context for teaching science.

Integrated science provides a means of reducing the sheer amount of material covered, to foster a scientific way of thinking, and to pay more attention to the nature of science and the interactions of science and technology with each other and with society. Science is often presented as a catalogue of facts, a cavalcade of activities that are seemingly unrelated. Themes can be a useful way to bring cohesion and unify scientific concepts. In an integrated science curriculum such as Science 10–20–30, many opportunities exist to show how the individual disciplines are connected by thematic strands. This does not mean that the curricula should be organized around themes; rather, the curricula should be permeated by themes.

This does not mean that the curricula should be organized around themes; rather, the curricula should be permeated by themes.

Themes can be used to lay out basic principles of science that will operate in many fields and subfields of science. Consider the example of the theme of energy. In the current Science 10 course, the theme of energy is introduced in the context of solar energy sustaining life and driving the weather on Earth. The second unit illustrates the importance of energy in life processes, in particular, the cell. The third unit investigates the interaction of matter and energy in chemical reactions. The final unit in Science 10 examines different forms of energy and the principles that govern energy transformations. In this manner the student learns about energy in a variety of different contexts; that the basic concepts related to energy can be applied widely in several disciplines; and that energy is a major overarching idea of science. This is an example of a horizontal use of the theme that cuts across disciplinary boundaries. If themes recur from one year to the next or from one course to another, as is the case with energy (e.g., energy from the biomass in Science 20, and energy systems in Science 30), then the student will again see the unity of seemingly diverse concepts relating to energy. This progression of understanding from course to another, as in Science 10–20–30, is an example of vertical integration of themes.

It will be helpful for science teachers at all grade levels to be aware of the continuity between the junior and senior high school science programs. Both the junior and senior high school science programs emphasize the interactions of science, technology and society. The differences between the two programs have to do with developmental needs and abilities in students at the two levels. Where the junior high approach is one of developing operational understandings, the senior high program tends to be more analytical and goes much farther in developing abstract understandings of nature of science, the nature of technology, and the interactions among science, technology and society. The units of study for the two programs are outlined below.

Both the junior and senior high school science programs emphasize the interactions of science, technology and society.

Junior High Science

Science 7
1. Characteristics of Living Things
2. Structures and Design
3. Force and Motion
4. Temperature and Heat Measurement
5. Micro-organisms and Food Supplies
6. Evidence of Erosion

Science 8
1. Solutions and Substances
2. Energy and Machines
3. Consumer Product Testing
4. The Earth's Crust
5. Growing Plants
6. Interactions and Environments

Science 9
1. Diversity of Living Things
2. Fluids and Pressure
3. Heat Energy: Transfer and Conservation
4. Electromagnetic Systems
5. Chemical Properties and Changes
6. Environmental Quality

Science 10–20–30

Science 10
1. Energy from the Sun
2. Matter and Energy in Living Systems
3. Matter and Energy in Chemical Change
4. Energy and Change

Science 20
1. Changes in Living Systems
2. The Changing Earth
3. Chemical Changes
4. Changes in Motion

Science 30
1. Living Systems Respond to Their Environment
2. Chemistry in the Environment
3. Electromagnetic Energy
4. Energy and the Environment

In addition to continuing the STS themes introduced in junior high science, the Science 10–20–30 program builds on the solid foundation of science developed in junior high, as illustrated below for Science 10.

Junior High Science	Science 10
Science 8 Unit 5: Growing Plants Science 9 Unit 3: Heat Energy: Transfer and Conservation	Unit 1: Energy from the Sun
Science 8 Unit 5: Growing Plants Science 8 Unit 6: Interactions and Environments Science 9 Unit 1: Diversity of Living Th. gs	Unit 2: Matter and Energy in Living Systems
Science 8 Unit 3: Solutions and Substances Science 9 Unit 5: Chemical Properties and Changes	Unit 3: Matter and Energy in Chemical Change
Science 7 Unit 3: Force and Motion Science 7 Unit 4: Temperature and Heat Measurement Science 8 Unit 2: Energy and Machines Science 9 Unit 3: Heat Energy: Transfer and Conservation	Unit 4: Energy and Change

C. SPECIFIC LEARNER EXPECTATIONS

LEARNING CYCLE

The specific learner expectations consist of the attitudes, skills and knowledge that are to be addressed in Science 10. The use of the learning cycle allows students to progress from:

- an introduction that frames a lesson in an STS connection that is relevant to the lives of the learners, to
- the experiential exploration of a new idea or content, through
- a hypothesis-building stage where concepts are developed to describe the results of the initial exploration, to
- an application phase where the hypotheses, vocabulary and patterns previously developed are applied to new situations and related to key concepts and principles of science, to
- a final evaluation of the significance of the new learning in an STS context.

Students examine phenomena in a variety of areas to show the relationships among the traditional science disciplines. Wherever possible, examples are drawn from their own experience to enable students to make the connection between scientific knowledge and the society around them, the technology that societies have developed, and the nature of science itself.

COURSE OVERVIEW

Science 10 emphasizes three of the key concepts of science: *energy, matter* and *change*. The concepts of *systems, diversity* and *equilibrium* are included as well but receive less emphasis. These conceptual themes provide a means of showing the connections among the scientific disciplines, and provide a framework for teachers to show students how individual sections of the course relate to the big ideas of science.

In addition to developing a solid understanding of the fundamental science concepts and principles, Science 10 has the goal of educating students about the nature of science and the interaction of science and technology. Students are made aware of the tremendous impact of science and technology on society, as well as the roles and limitations of science and technology in STS problem solving.

Science 10 consists of four units of study:

Unit 1: Energy from the Sun
Unit 2: Matter and Energy in Living Systems
Unit 3: Matter and Energy in Chemical Change
Unit 4: Energy and Change.

Unit 1 focuses on the role of radiant energy from the Sun in sustaining life and driving weather systems on Earth. In Unit 2, the processes by which matter and energy are exchanged between living systems and their environment are studied, and change is illustrated by the growth of living organisms. Unit 3 investigates the changes in matter and energy that occur during chemical reactions. Unit 4 examines different forms of energy and the principles that govern energy transformations.

Course of Studies

Applicable Resources inserted into the course of studies to facilitate planning • Print * AV

UNIT 1
ENERGY FROM THE SUN

OVERVIEW

Science Themes: *Energy, Matter* and *Change*

In Unit 1, students investigate how radiant *energy* from the Sun sustains life and drives weather systems on Earth. The properties of water are studied and compared with the properties of other forms of *matter*. Students investigate the role of water in moderating the *changes* in the Sun's *energy* as it moves through the biosphere.

This unit builds on Science 8, Unit 5: Growing Plants; and Science 9, Unit 3: Heat Energy: Transfer and Conservation, and provides students with a foundation for the study of ecosystems and alternative *energy* sources in the 20- and 30-level science courses.

The three **major concepts** developed in this unit are:

- *energy* from the Sun sustains life on Earth
- the properties of water, relative to other forms of *matter*, profoundly influence the nature of life on Earth
- weather *systems* moving through the hydrosphere and the atmosphere are driven by *energy* from the Sun.

In this unit, students will develop an ability to use the **skills and thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from their investigations of the Sun's *energy* and the properties of water.The **STS connections** in this unit illustrate:
- the functioning of products or processes based on scientific principles
- the use of technology to solve practical problems
- the limitations of scientific knowledge and technology.

ATTITUDES

Students will be encouraged to:

- develop a questioning attitude concerning natural phenomena
- appreciate the importance of solar energy in sustaining life and driving weather systems on Earth
- appreciate the importance of water in determining the nature of life on Earth
- recognize that scientific knowledge of meteorological phenomena is cumulative and subject to change
- respect the role of empirical evidence in developing scientific theories related to weather
- recognize the limits of current scientific theories in predicting natural phenomena, such as weather.

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. Energy from the Sun sustains life on Earth. •Atlas of Environmental Issues *Atmosphere (World of Chemistry Series) •Conservation Strategy *Disappearing Forests (Spaceship Earth Series) *Energy (Science Show Series) *Energy Flow in the Biosphere (Energy Flow Series) *Global Warming (Climate and Man Series) *Global Warming: Hot Times Ahead *Light and Energy •One Minute Readings •Our Environment *Photosynthesis (Energy Flow Series) *Photosynthesis and Assimilate Transport *Seeing the Light (Photosynthesis Series) •Toward a Common Future •Understanding Our Environment	• energy from the Sun sustains life on Earth, by extending from Science 8, Unit 5, the life processes of plants, and by: • defining photosynthesis as the process by which green plants put together carbon dioxide and water to store energy and form carbohydrates and oxygen • defining aerobic respiration as the process by which organisms release energy by reacting on carbohydrates and oxygen to form carbon dioxide and water • indicating that all life on Earth exists in the biosphere, a relatively thin spherical shell having an approximate thickness of 15 kilometres • indicating that the biosphere exists within the three major spherical layers of Earth—the atmosphere, the hydrosphere and the lithosphere
2. The properties of water, relative to other forms of matter, profoundly influence the nature of life on Earth. *The Biology of Water (Science Screen Report Series) •One Minute Readings •Our Environment •Toward a Common Future *Water (World of Chemistry Series) *Water: A Fascinating Liquid	• the properties of water, including surface tension, melting point, boiling point, specific heat capacity, heat of fusion, heat of vaporization, expansion on freezing, and maximum density at 4°C, profoundly influence the nature of life on Earth, by: • extending from Science 9, Unit 3, that heat is a form of energy and may be quantified using $Q = mc\Delta T$ • calculating the thermal energy involved when a measured mass of water undergoes a measured temperature change • relating the hydrologic cycle to solar energy • relating the properties of water to the maintenance of constant body temperature • indicating why ice forms on the surface of water, and relating this to the winter survival of aquatic organisms

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• performing an experiment to investigate the production of carbohydrates and oxygen by green plants • identifying the manipulated, responding and controlled variables (variables held constant) in an experimental investigation of photosynthesis • designing a closed system to illustrate the dynamic balance between photosynthesis and respiration • tracing the flow of energy through the biosphere, using diagrams	• tracing the energy contained in a typical student lunch to its source in the Sun • describing how a greenhouse can be used as a model of Earth's atmosphere • describing the technology used to monitor levels of atmospheric gases • discussing the implications of global deforestation
• observing and recording some of the physical properties of water • collecting and graphing data showing the effect of heat on the temperature of water • performing an experiment to determine the heat of fusion of ice • graphing and analyzing data showing how the density of water varies with temperature • designing an experiment to investigate the change in volume of water on freezing	• explaining why perspiration can keep a person from overheating on a hot day • describing how the expansion of water, upon freezing, is accounted for in construction in cold climates • explaining technologies that use solar energy to desalinate water, in terms of the scientific principles involved • describing technologies that use water to maintain a uniform temperature in buildings in terms of the scientific principles involved

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:

3. Weather systems moving through the hydrosphere and the atmosphere are driven by energy from the Sun.	• weather systems moving through the hydrosphere and the atmosphere are driven by energy from the Sun, by:
	  • explaining why large bodies of water have a moderating effect on the climate of surrounding areas
	  • describing the role of ocean currents in transferring thermal energy; e.g., Gulf Stream, Japan Current, El Niño
	  • relating latitude and surface characteristics (e.g., snow, oceans, forests) to the amount of solar energy absorbed and lost by Earth
	  • explaining the significance of the differential solar heating of equatorial and polar regions in the transfer of thermal energy
	  • explaining weather changes in terms of pressure systems, cold and warm fronts, and the Coriolis effect
	  • explaining the occurrence of chinooks in terms of the heat produced by the compression of air
	  • explaining the formation of thunderstorms and hailstorms in terms of vertical air currents
	  • explaining the formation of tornadoes in terms of vertical air currents and a cold front.

*The Blue Planet: Physical and Chemical Makeup of the Oceans
*The Blue Revolution: The Return of the Child: The Effects of El Niño
•Climates of Canada
*Exploring the Atmosphere: Meteorology in Canada
*Geology and Meteorology
•Learning Weather – A Resource Study Kit
*Living Textbook – Geology and Meteorology
•National Geographic Atlas of the World
*Sun, Sunlight and Weather Pattern
*Swirling Seas
•Understanding Weather and Climate
•The Weather Companion

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• comparing mean monthly temperature data for cities of similar latitude and accounting for any differences	• explaining the difference in climate between the Prairies and the West Coast
• constructing and interpreting climate graphs	• explaining how local weather phenomena are driven by energy from the Sun
• designing an experiment to investigate the heating effect of solar energy	• describing the operation of weather satellites in monitoring weather systems
• observing and describing the Coriolis effect	• describing the operation of radar in tracking thunderstorms
• evaluating meteorological models currently used to explain and predict weather patterns	• explaining how more accurate weather predictions could benefit millions of people globally.
• performing an experiment to investigate the heat changes involved in the compression and expansion of air	
• communicating meteorological data in SI units; e.g., temperature, wind velocity, atmospheric pressure, precipitation.	

UNIT 1 – Energy From the Sun Lesson Exemplars

Exemplar 1 Comparing Weather Predictions

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *energy* and *change*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *differentiating between relevant and irrelevant data or information*
- *formulating questions, hypotheses and/or predictions to guide research*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating data more effectively, using mathematical and statistical calculations where necessary*
- *communicating findings of investigations in a clearly written report*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying assumptions, attributes, biases, claims or reasons*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *formulating further testable hypotheses supported by the knowledge and understanding generated*
- *proposing and explaining interpretations or conclusions*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *establishing criteria to judge data or information*
- *considering consequences and perspectives*
- *identifying limitations of the data or information, and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *evaluating and assessing ideas, information and alternatives*

*The **STS connections** emphasized are:*

- *the inability of science to provide complete answers to all questions*
- *the use of technology to solve practical problems*
- *the limitations of scientific knowledge and technology*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *describing the role of ocean currents in transferring thermal energy; e.g., Gulf Stream, Japan Current, El Niño*
- *relating latitude and surface characteristics (e.g., snow, oceans, forests) to the amount of solar energy absorbed and lost by Earth*
- *explaining the significance of the differential solar heating of equatorial and polar regions in the transfer of thermal energy*
- *explaining weather changes in terms of pressure systems, cold and warm fronts, and the Coriolis effect*

Skills

- *constructing and interpreting climate graphs*
- *evaluating meteorological models currently used to explain and predict weather patterns*
- *communicating meteorological data in SI units; e.g., temperature, wind velocity, atmospheric pressure, precipitation*

STS Connections

- *explaining how local weather phenomena are driven by energy from the Sun*
- *describing the operation of weather satellites in monitoring weather systems*
- *describing the operation of radar in tracking thunderstorms*
- *explaining how more accurate weather predictions could benefit millions of people globally*

Comments: Students should be introduced to at least some of the specific learner knowledge and skill expectations prior to this lesson. *Visions 1*, Chapter 3 provides required facts, diagrams, suggestions for activities and review questions.

One class period is required to set up the study. A student report will be submitted one month later.

Teachers may find it interesting and worthwhile to carry out the study personally at the same time as the students.

Introduction

The following activity may be used to introduce weather predicting.

Teacher Activity	Student Activity
• Write the following message on the board: "Red sky at night, sailors' delight. Red sky in the morning, sailors' warning"	• Some students may indicate that the verse was once used to predict weather patterns. Many students may reject the saying, believing that folklore has no scientific basis.
• What does the message mean?	
• Teacher provides an explanation for the verse. Sailors learned to forecast weather from cloud patterns and winds. On the Atlantic Ocean, winds come predominantly from the west. At dusk, while the sun is slowly setting in the west, clouds directly above the sailor are illuminated by the rays of the sun producing a red colour. This would mean a clear day ahead. However, should clouds be collecting to the west, the setting sun will not be seen. The assumption is that the clouds carrying rain will move toward the sailor the following day. As the sun rises, clouds to the west become visible. A red colour is produced as light is refracted by water and dust in clouds. Clouds to the west in the morning mean that rain clouds could be moving toward the sailor, hence the warning.	• Students may mention the migration of birds as either a sign of spring or fall. Many individuals insist that early migration forewarns of an early winter. (There is no current scientific evidence that demonstrates that birds are better able to forecast early winters.) Groundhogs are used to predict the duration of winter or the coming of spring. Beetles have been used to predict rainfall. Some individuals believe that beetles become agitated just before a rainstorm. Many other examples can be provided.
• Students are encouraged to come up with other folklore beliefs associated with weather predictions. Teacher writes student examples on the board.	

- excellent opportunity to involve ESL and Native students
- *Weather Wisdom: Facts and Folklore of Weather Forecasting* by Alberta Lee (New York: Congdon & Weed, Inc., 1976) has numerous examples of weather folklore.

Exploration

- students read the appropriate section in *Visions 1*, Chapter 3
- examine almanacs, newspaper reports, simple weather forecasting instruments
- view video on weather forecasting or watch a televised weather newscast
- examine weather maps, photographs of different cloud formations
- take a mini-field trip into school yard to observe weather conditions for that day

Development

The following activities may be used to describe the results of the initial exploration.

Teacher Activity	Student Activity
• Has anyone ever used an almanac?	• Students are most often familiar with the Farmer's Almanac.
• Can you explain how it works?	• Average temperatures and rainfall are used to determine statistically what will happen on a given day. Predictions are based on prior tendencies.
• How are the data collected from almanacs different from that used by the weather forecaster? OR • How are data collected by professional weather forecasters?	• Students indicate that weather forecasters use satellites and remote sensing instruments to track cloud movements and cold fronts. Weather stations also use weather balloons which are equipped with barometers, thermometers, anemometers. Hygrometers and rain gauges are also used by forecasters.
• Students are asked to comment on the accuracy of almanacs.	

– teacher could also refer directly to the **Specific Learner Expectations** section at the beginning of this exemplar

Application

Teacher Activity	Student Activity
• Students are asked to obtain an almanac with weather predictions for their local area.	• The almanacs can be found at most libraries.
• Students will compare weather predictions made by the almanacs, and weather forecasters, with their own predictions for a one-month duration. A sample chart is provided below.	• Students will construct a data table which records their predictions, as well as those made by the almanac and local weather forecaster. Predictions will be entered for a three-day period, every three days for the entire month. Students can save newspapers and record the predictions made by weather forecasters after the three-day period has passed to avoid being influenced in their predictions In all cases student predictions must be entered prior to that of the weather forecaster. Students may use cloud formations or any other monitoring device they wish, but listening to or reading about weather forecasts should be avoided.

Teacher Activity

- Compare the accuracy of your predictions to those of the weather forecaster and the almanac. You must use graphs, charts, and statistical analysis in your report. Accuracy of prediction can be reported in percentages:

$$\% = \frac{\text{\# of correct prediction}}{\text{total \# of predictions}} \times 100$$

The following must appear in the assignment:

1. Data table.
2. Analysis of data (appropriate analysis of data, i.e., pertinent calculations, graphs). This should include a description of the rationale they used in making their prediction.
3. Conclusions
   - i) How has technology aided forecasting?
   - ii) Are modern technologies more accurate?
   - iii) Why is accurate forecasting important?
   - iv) How could more accurate weather forecasting benefit people globally?

Student Activity

- Students are encouraged to use statistics to show their findings. Graphs are especially useful in expressing trends. Although no specific number of data tables or graphs are indicated, students should keep in mind that conclusions must be supported by data.

Data Table

Sample:

Date	Condition	My prediction	Almanacs' prediction	Weather forecasters' prediction	Actual weather
	Daily max.				
	Daily min.				
	Precipitation (yes/no)				
	Cloud cover (Cloudy/ partly cloudy/ sunny)				

Description of methodology you used to make your predictions:

_____

_____

_____

Significance

Connections with Nature of Science

- This lesson provides an excellent opportunity for students to begin looking at how folklore has affected the development of science. Many things, once attributed to superstition or fable, have since been supported by science. Students may come to realize that some cures or potions were used because they worked, even if an understanding wasn't provided. Folklore medicines arose, through observation of the effect of certain treatments. Unlike science, folk medicine did not investigate the cause behind the effect, often attributing the effect to supernatural causes. Although the practices or potions may have worked, the lack of a scientific explanation means that a cause and effect relationship was not presented. (Aspirin™ and many other drugs had been used before scientists really understood what they did. Even today, a complete explanation cannot be given. The use of ASA dates back to North American Indians using boiled bark from trees.)

- Students have an opportunity to collect and synthesize data, develop a hypothesis, and draw conclusions. As specific instructions are not given for which graphs, data tables or charts to include, students have a greater opportunity to work as scientists.

- Students have an opportunity to compare technological data collection, via satellites and radar scans, to statistical analysis of data in order to make predictions (almanacs).

Connections with Technology

- Although monumental advances in science and technology have contributed to our understanding of weather, predictions are not always 100% accurate. Weather prediction provides teachers and students with an opportunity to talk about science as an inquiry, rather than as a process which always ensures correct answers. Students should gain an appreciation for the many natural variables which affect weather, and the limitations of scientists, even with advanced technology, to provide all of the answers.

- Although the initial focus of the lesson is on comparing ways in which weather prediction can be made, students soon come to realize that technological methods are most often highly valued, even though they are not always correct. Students have an opportunity to discuss why society has become so convinced that technology supplies the best or most accurate answers.

- This lesson provides an opportunity for students to learn more about the technology which supports weather predictions.

Connections with Science-Related Social Issues

The importance of accurate weather forecasting for farmers, here in Canada and globally, should be reinforced.

Evaluation

The following scale may be used to mark student reports.

	Mark		
Category	1	2	3
Data	Entries were not made for one of the categories. (e.g., almanac predictions)	Data table is not well organized. Some entries missing.	Data table well organized, and data is presented in a clear and concise manner.
Analysis	Analysis is not complete. Either calculations or graphs not provided.	Some difficulties in presentation of graphs, or charts or calculations are incorrect. (Poor graphing skills, coordinates incorrect, labels or units missing, etc.)	Calculations are accurate and graphs or charts synthesize data. Appropriate graphing techniques include titles, units, labelled axis, correct number sequencing, and correct positioning of coordinates
Conclusions 1. Generalizations made (hypothesis formation)	Generalizations about the accuracy of weather forecasting are not made or so poorly expressed that the intent can not be followed.	Generalizations about weather forecasting are made, but not supported by data collected. More than one reading is required to decipher intent.	Generalizations are based on data presented. Data are used to support hypothesis. Expression is clear, and logical thought is presented.
2. Social aspects identified and presented.	The social benefits of weather forecasting demonstrates incorrect understanding of the technology or the problem.	Expression of social benefits of weather forecasting does not relate the technology to the problem. More than one reading is required to understand intent.	Social benefits of weather prediction relates technology to the problem. Clear, correct, logical thought is expressed.

In addition, ask students to:

- reflect on personal performance
- suggest improvements to methods used
- compose own "weather wisdoms" in the form of rhymes, raps, etc.
- reflect on value of this study; i.e., How has this study benefited you?

If teacher carried out the investigation at the same time as students, it may be interesting and worthwhile to compare results – let students evaluate the teacher's report.

Exemplar 2 Storing Thermal Energy

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *energy* and *matter*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying all variables and controls*
- *identifying materials and apparatus required*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating data more effectively, using mathematical and statistical calculations where necessary*
- *expressing measured and calculated quantities to the appropriate number of significant digits, and using appropriate SI units for all quantities*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying main ideas*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *formulating further testable hypotheses supported by the knowledge and understanding generated*
- *identifying further problems or issues to be investigated*
- *proposing and explaining interpretations or conclusions*
- *developing theoretical explanations*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *considering consequences and perspectives*
- *evaluating and assessing ideas, information and alternatives*
- *suggesting alternatives and considering improvements to experimental technique and design*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted*
- *the functioning of products or processes based on scientific principles*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*
- *the influence of the needs, interests and financial support of society on scientific and technological research*

Specific Learner Expectations

Knowledge

- *extending from Science 9, Unit 3, that heat is a form of energy and may be quantified using* $Q = mc\Delta T$
- *calculating the thermal energy involved when a measured mass of water undergoes a measured temperature change*
- *relating the hydrologic cycle to solar energy*
- *relating the properties of water to the maintenance of constant body temperature*
- *explaining why large bodies of water have a moderating effect on the climate of surrounding areas*

Skills

- *observing and recording some of the physical properties of water*
- *collecting and graphing data showing the effect of heat on the temperature of water*
- *designing an experiment to investigate the heating effect of solar energy*
- *communicating meteorological data in SI units; e.g., temperature*

STS Connections

- *explaining why perspiration can keep a person from overheating on a hot day*
- *explaining technologies that use solar energy to desalinate water, in terms of the scientific principles involved*
- *describing technologies that use water to maintain a uniform temperature in buildings in terms of the scientific principles involved*
- *explaining the difference in climate between the Canadian Prairies and the West Coast*
- *describing how a greenhouse can be used as a model of Earth's atmosphere*

Comments: This lesson builds on Science 9, Unit 3; review of relevant concepts of junior high science may be required before beginning the experiment.

Time is an important factor in this experiment. Teachers may wish to encourage students to collect data throughout the school day, or plan to spend two days on this activity.

Introduction

Teacher Activities	Student Activities
• Shows picture of pavement and lush forest area.	• Students indicate cement feels hotter on hot days.
• Where would you prefer to work if air temperatures were near 40 °C?	
• Brainstorming groups of preferably 3 (or 4) students are assigned. Each group assigns task of recorder, group reporter, and one or more scouts who will seek points from other groups. Groups are asked to list factors which make the cement hotter.	• List may include factors like colour of pavement (i.e., black surfaces tend to absorb thermal energy; snow reflects thermal energy); shade (i.e., trees) makes the area cooler; or comparisons of molecular structure (i.e., denser materials are generally better conductors of thermal energy).
• Teacher asks one volunteer group to provide its findings.	• Other groups may volunteer to provide additional points.

Alternative Activities

Challenge students to explain one or more of the following:

- why you feel no pain if you wet fingers before extinguishing candle flame
- why you can "test the heat" of an iron by touching it with a wet finger
- why drops of water "dance" if added to a hot pan
- why, if you bite into a hot pizza, the cheese will burn your tongue but the bread base will not
- why you can put your hand into a hot oven without burning it, yet you need a pot holder to touch the pan that is inside the oven.

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

Exploration

Teacher Activities	Student Activities
• Students are asked to remain in their brainstorming groups. Student groups are permitted 5 minutes to read through the laboratory activity (on next page).	• Students read through the laboratory activity and, if appropriate, ask questions.
• Students are asked to identify three independent variables outlined in the laboratory activity.	• Groups identify the three variables Newspaper, Water and Soil.
• Groups challenged to identify other variables and provide a reason for wanting to determine the ability of the substance to store solar energy.	• Variables identified and shown to teacher • Reasons for selecting the material are provided.
• Teacher lists, on the board, some of the variables identified by lab groups.	
• Teacher facilitates students as they set up equipment.	• Student groups to begin laboratory, but substitute one or more of their variables in place of those provided in the laboratory. (It is recommended that all groups use water and air, along with one or two other variables.)
• Teachers assigns questions 1, 2, 3 and 4 and advises students that much valuable information can be found in *Visions 1*, Chapter 2.	

Objective

To identify materials that are suited for collection and storage of solar energy.

Materials

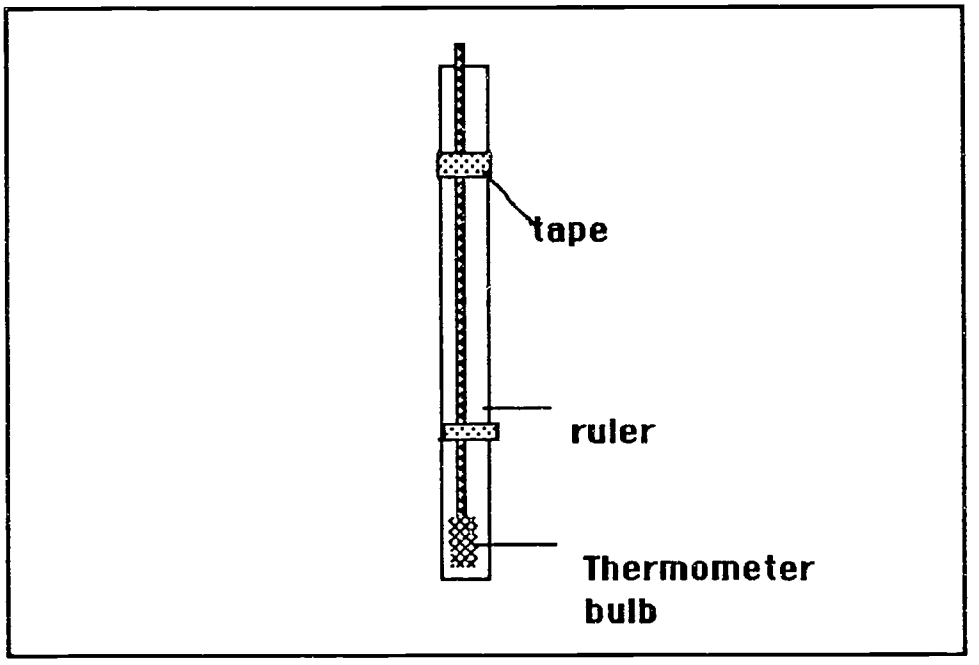
Thermometer	Black paper
Ruler	Tape
3 empty tin cans (same size)	
Newspaper	Sand or potting soil
Water	Shoe box

Procedure

1. Line the inside of a cardboard shoe box with black paper.

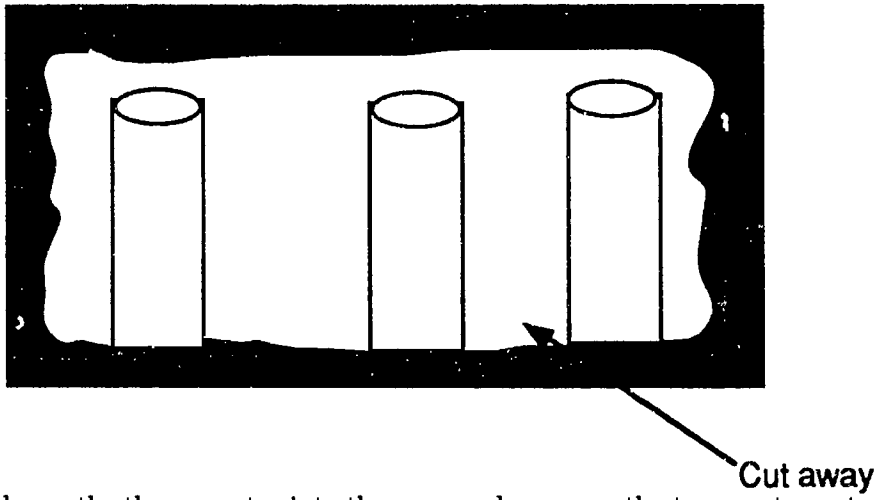
2. Tape a thermometer to a ruler as shown in the diagram on the next page.

Caution: Make sure that the end of the ruler extends beyond the bulb of the thermometer.



3. Fill each of the cans with water, shredded newspaper, and sand respectively. Record the initial temperatures of the sand, newspaper, and water on Table A.

4. Place the cans in the black box and leave them in a sunny place for 20 minutes. Do not place a lid on the black box.



5. Carefully lower the thermometer into the cans and measure the temperature at a depth of 5 cm. Record the temperatures of the three materials after 20 minutes on Table A.

6. Remove the box with the three cans from the sunlight and place them in the shade and record the temperature after 20 minutes.

Table A

Material	Initial Temp °C	Heated Temp °C	Cooling Temp °C
Sand			
Newspaper			
Water			

*Students will have to modify this table to include the variables that they have chosen.

Questions

1. Why was black paper used to line the shoe box?
2. Which material changed temperature fastest? Provide an explanation that accounts for your observations.
3. Which material held the heat the longest? Provide an explanation that accounts for your observations.
4. You were asked to take your readings consistently 5 cm below the surface of the materials tested. How would surface temperatures differ from temperatures well below the surface? Explain your answer.

Development

The teacher directs a class discussion of students' results.

Refer to the following suggested answers to the questions posed in the exploration stage.

Questions

1. Why was black paper used to line the shoe box?

   Black paper absorbs all wavelengths of light. Black paper holds the thermal energy.

2. Which material changed temperature fastest? Provide an explanation that accounts for your observations.

   Although answers will vary with matter selected, students should draw on explanations which address factors such as mass and heat capacity. Drawing on previous evidence, students know that air temperatures change faster than water temperatures. This question requires students to apply Q(heat)= m(mass) x c(heat capacity) x ΔT(change in temperature). Students should also express an understanding of heat capacity as different amounts of heat are required to raise the temperature of matter 1°C. (Sample: the newspaper changes temperature the fastest. The matter (newspaper and air in the can) is less dense, and therefore, less energy was needed to heat fewer molecules. The air also has a much lower heat capacity than water has. When water is heated, much of the energy must be used to overcome the intermolecular forces before the energy can be used to increase molecular motion.)

3. Which material held the heat the longest? Provide an explanation that accounts for your observations.

Answers will vary with independent variables that the group selected, but here are some points to consider. For example, the surface of the sand will heat faster than the surface of the water, but also cool faster. Denser materials are better conductors of heat. The molecules found in a solid are in a fixed position. Therefore, energy received from Sun will be conducted to layers beneath the surface. Cement or denser materials like iron heat quickly and cool quickly. Water molecules with strong intermolecular forces have a high heat capacity This means that energy is used to overcome bonds between water molecules before the kinetic energy of water molecules increases. (Temperature can be explained in terms of molecular motion. When temperatures are high the average speed of water molecules is greater than when the temperature is lower.) Therefore, the water tends to heat more slowly, but it also tends to lose heat more slowly.

4. You were asked to take your readings consistently 5 cm below the surface of the materials tested. How would surface temperatures differ from temperatures well below the surface? Explain your answer.

Temperatures at the surface were directly exposed to the Sun, and therefore had received the greatest amount of thermal energy. Energy in the form of heat passes from molecules at the top to the underlying molecules by conduction.

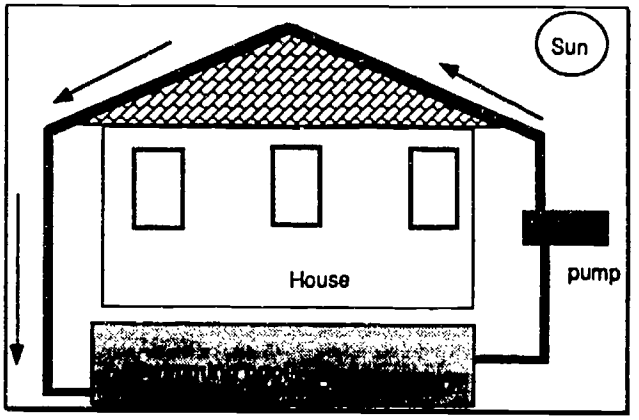
Application

Questions 5 and 6 may be assigned.

5. Using the information gathered in the laboratory activity, explain why a lake feels cooler on a hot day than it does on a cool day.

The lake is likely the same temperature or very close to the same temperature on the hot day and cool day. Lakes, because of the higher heat capacity of water, warm more slowly than air or land. Both air and land have a lower specific heat, meaning less heat is required to create a change in temperature. Given that the molecules of water have greater intermolecular forces, more energy is required to change the temperature of water. Water also tends to hold the heat better than the air or land. (Students may have observed that solids, for example buildings, hold heat even after air temperatures cool at night.) The concept of specific heat is reviewed from junior high science in this question.

6. The diagram below show coils of black piping running along the roof of a house. The black piping leads into a swimming pool. What is the black piping used for? Explain how the apparatus works.



The black piping heats the water going into the pool. The water is heated by the sun. As the water heats, it rises up the tube and returns to the pool creating a convection current. Once the water reaches the pool it must be pumped back into the pipes to be heated once again.

- Students may tackle challenge questions presented in the introduction – come up with "better" (more scientific) answers.

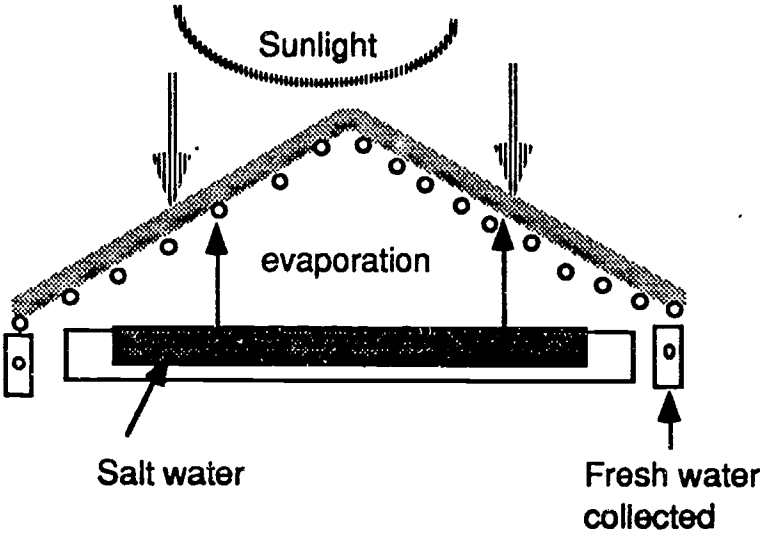
- Students can measure heat capacity by using a calorimeter. Different materials which can be used for heat storage can be identified. A material with high heat capacity can absorb a great deal of heat before its temperature rises. The substance would heat up slowly during the day and cool down slowly at night.

- Students can be challenged to find uses for materials with high heat capacity. The ceramic tiles used on the space shuttle may be one example.

- Students may build a model of a solar house which uses hot water heating. Due to the high heat capacity of water, a relatively small amount of water can distribute a substantial amount of heat.

- Students can also explore different cooling systems. Because water has a high heat capacity, relatively small amounts of water can absorb relatively large amounts of heat.

- An understanding of how solar energy drives the hydrological cycle can be used to investigate solar stills. Sunlight energy can be utilized for distillation. Students can build various types of solar stills, which are designed to separate salt from water. The diagram below shows one example of a solar still.



- Students can also be provided with an opportunity to build a solar cooker. Various types and models can be constructed.

- Solar energy technology can be explored by examining solar photovoltaic cells. First developed in the Bell Laboratories in 1954, the photovoltaic cell is composed of two layers of silicon. Sandwiched between the silicon layers are other elements like aluminum, arsenic, or boron.

Different cells are available at reasonable prices. Students can research how the solar cells work or use the solar cells to generate power for various devices.

- Students may be provided with a challenge to research how solar technology has been used in space. In 1973, Skylab was fitted with solar cells arranged in large wing-like panels. The cells provided enough power for the astronauts to carry out scientific experiments for 7.2 days. Many students have calculators which are operated by solar cells.

Significance

- Because water has a high heat capacity, it is ideal for cooling systems. Unfortunately, water used by industry as a coolant is often flushed back into the lakes and rivers. Not only does the water carry pollutants, but it can substantially change the temperatures of a lake or river ecosystem. Thermal pollution is a major ecological problem.

- Environmental, technological, and economic issues associated with using solar energy may be explored. Many students believe that solar cells should replace chemical batteries; however, they often do not understand some of the difficulties associated with using solar energy. Chemical batteries still produce greater voltage, per cell, and are not affected by clouds and weather patterns. Chemicals that can be hazardous to the environment are used in some solar batteries, and the expense is still greater than conventional energy sources.

- The technology associated with solar stills can be used to explore many water quality issues.

- The impact of the greenhouse effect relative to changes in the amount of solar energy that the atmosphere stores may be explored.

- The impact of cities (cement structures) or deforestation on weather patterns can be explored.

- The high heat capacity of water is a vital factor in the maintenance of normal human body temperature – consider marathon running or the drinking of alcoholic beverages after exercising on a hot day.

Evaluation

Teachers may wish to use the following scale to assign group marks.

1. **Not acceptable**

   Design is flawed. Variables are not controlled. Little evidence of effort. Basic misunderstandings presented in questions at the end of the laboratory. Written communication is difficult to understand.

2. **Average**

   Alternate independent variables are identified and extraneous variables are controlled. Communication of experiment is adequate; however, some difficulties may exist with the control of variables or application questions at the end of the laboratory.

3. **Very good**

Alternate independent variables are identified and extraneous variables are controlled. Communication of experiment is clear. Answers at the end of the lab convey a clear understanding of thermal energy. Experimental design demonstrates an understanding of the concepts studied and limitation of variables.

1. Independent variables are identified and extraneous variables are controlled	1	2	3
2. Answers at the conclusion of the laboratory indicate understanding (questions 1 to 3).			
3. Answers at the conclusion of the laboratory indicate understanding (questions 4 to 6).			
4. Group works cooperatively. • All members of the group treated with dignity and respect • All members of the group assigned and carried out a task.			

Students may be marked individually on their responses to challenge questions.

Groups or individuals may be evaluated on any of the suggested application activities undertaken.

The significant issues presented as a result of this lesson may provide themes for position papers, role playing scenarios or debates.

Exemplar 3 Studying Infrared Photography

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *matter, energy* and *change.*

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *differentiating between relevant and irrelevant data or information*
- *identifying materials and apparatus required*
- *formulating questions, hypotheses and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*

Collecting and Recording

- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating findings of investigations in a clearly written report*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying main ideas*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *identifying further problems or issues to be investigated*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *establishing criteria to judge data or information*
- *considering consequences and perspectives*
- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *suggesting alternatives and considering improvements to experimental technique and design*

*The **STS connections** emphasized are:*

- *the functioning of products or processes based on scientific principles*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *indicating that all life on Earth exists in the biosphere, a relatively thin spherical shell having an approximate thickness of 15 kilometres*
- *indicating that the biosphere exists within the three major spherical layers of Earth – the atmosphere, the hydrosphere and the lithosphere*
- *relating the hydrologic cycle to solar energy*
- *describing the role of ocean currents in transferring thermal energy; e.g., Gulf Stream, Japan Current, El Niño*
- *relating latitude and surface characteristics (e.g., snow, oceans, forests) to the amount of solar energy absorbed and lost by Earth*
- *explaining weather changes in terms of pressure systems, cold and warm fronts, and the Coriolis effect*
- *explaining the occurrence of chinooks in terms of the heat produced by the compression of air*
- *explaining the formation of thunderstorms and hailstorms in terms of vertical air currents*
- *explaining the formation of tornadoes in terms of vertical air currents and a cold front*

Skills

- *observing and recording some of the physical properties of water*
- *observing and describing the Coriolis effect*

STS Connections

- *describing how a greenhouse can be used as a model of Earth's atmosphere*
- *describing the technology used to monitor levels of atmospheric gases*
- *discussing the implications of global deforestation*
- *explaining the difference in climate between the Canadian Prairies and the West Coast*
- *explaining how local weather phenomena are driven by energy from the Sun*
- *describing the operation of weather satellites in monitoring weather systems*
- *explaining how more accurate weather predictions could benefit millions of people globally*

Comments: This lesson enables students to review and tie together the concepts, skills and STS connections emphasized in Unit 1 in an interesting manner.

Three class periods are required.

Teachers may find the following list of references helpful.

Introduction

Teachers can pose the following challenge questions to stimulate student interest:

How do weather satellites:
- produce night time images of cloud cover?
- determine water and air temperatures?
- distinguish the boundaries between cold and warm fronts?

How does a heat-seeking missile "find" its target?

OR

A week or two before beginning this lesson teacher can use infrared film to take "pictures" of students, various familiar objects, plants, animals, a beaker of hot water, a beaker of cold water, etc.

Since infrared film can be used in a conventional 35 mm camera, students need not know that anything unusual is happening. To introduce the lesson, the developed thermographs can be shown to students. They will definitely be interested.

OR

The Secret House (see reference) contains several excellent thermographs of familiar objects, human bodies and body parts – sure to create interest among students.

Sources for infrared pictures

1. Heimler, C, and C. Neal. *Principles of Science: Book Two.* Fourth edition. Merrill Publishing Company, 1979, page 397. This text should already be in most schools, and therefore, will decrease research time for the teacher. Figure 19.24 shows an infrared photograph of New Orleans. The following resources provide examples more relevant to students in Alberta.

2. Smith D.G. *Landforms of Alberta Interpreted From Airphotos and Satellite Imagery*, Alberta Remote Sensing Centre, Alberta Environment, Edmonton, 1987.

3. Fotheringham, R.R. *The Earth's Atmosphere Viewed From Space.* University of Dundee, 1979.

4. Environment Alberta. "The Changing Atmosphere." *Environment Views*, December 1988, This entire issue deals with how scientists monitor atmospheric changes and how scientists assess the impact of these changes. This excellent is written from high school students and can be obtained from Environment Alberta, 8920 106 Street,Edmonton , Alberta, T5K 2J6.

5. Science magazines available at local newstands

6. Bodanis, David. *The Secret House: 24 Hours in the Strange and Unexpected World in Which We Spend Our Nights and Days.* New York: Simon & Schuster Inc, 1986.

General information on infrared photography

The Kodak resources are designed for the hobbyist or student, and therefore are appropriate for the nonprofessional. Books can be ordered from most camera stores.

1. *Basic Scientific Photography (W-4)*
2. *Applied Infrared Photography (M-28)*

General Information about applications

1. Banner Allen V. *Overhead Imaging for Verification and Peacekeeping: Three Studies.* Arms Control Verification Occasional Papers No.6, Ottawa: Arms Control and Disarmament Division, 1990.
2. Rasool, S. I., ed. *Potential of Remote Sensing for the Study of Global Change: COSPAR Report to the International Council of Scientific Unions.* Advances in Space Researc, Vol. 7, No. 1, Oxford: Published for the Committee on Space Research by Pergamon Press, 1987.
3. Hobbs, R.J. and H.A. Mooney. *Remote Sensing of Biosphere Functioning.* Ecological Studies, Vol. 79, New York: Springer-Verlag, 1990.

Exploration

Teacher activities	Student activities
• Remote sensing pictures are shown to the class. (See reference list for sources for pictures.)	
• Students are asked how infrared pictures differ from conventional photographs.	• Familiar objects have the same appearance; however, students note the colour differences.
• Students are asked to interpret the picture.	• Bodies of water can be distinguished from land forms. Water tends to be various shades of blue, while buildings and objects which absorb thermal energy more rapidly may appear red or yellow. Coastal waters tend to be warmer and therefore, most often appear as light blue; cooler deeper water appears darker blue.
• How might the picture differ if the photograph was taken on a cold day?	• Students should be encouraged to speculate about how the picture might be changed. Many students will indicate that snow, should it appear, forms a blanket, thereby reducing much of the infrared radiation emitted from the ground and vegetation.

Development

Due to special nature of this lesson, teacher does not provide too much information.

Suggestions of Points to Include

- infrared photography uses conventional cameras, but makes use of specially sensitized film which detects near-infrared radiation (wavelengths between 700 and 900 nanometres)
- generally, warm objects give off more infrared radiation than cold ones do
- the colours of the objects in the thermograph (infrared photo) indicate relative warmth
- actual colours depend on film and filters used
- infrared radiation travels through clouds more easily than visible light does

Application

Teacher Activities	Student Activities
• Students are organized into cooperative learning groups of three students. (Due to class size some of the learning groups may have four class members). Groups will be paired with a partner group By having each partner group study a specific aspect of infrared photography, a jigsaw method of student-directed teaching may be employed.	• Each group appoints a chairperson who works with the group to assign tasks. Once tasks are assigned, each person in the group will assume primary responsibility for a single task. From that point onward, leadership within the group will become horizontal.
• Tasks are assigned Partner group A: (All prepared materials must be turned in as part of the groups evaluation). 1. The group must provide a brief description of how the technology works. How is infrared technology different from conventional photography? 2. Using library investigations identify at least two different infrared photographs of landforms from books, maps or magazines. Provide a complete bibliography indicating the source of the photograph. 3. Using one of the pictures from the reference source, replicate the photo by providing a colored drawing. 4. Design two questions which require members of your partner group to interpret the information provided by the photograph.	• Students are permitted to organize tasks, but must provide a record of who completed each task. Every task must have one person who assumes primary responsibility for seeing that the task is completed. Individuals who provided assistance should also be acknowledged. • Each student will be asked to evaluate the presentation of material given by the partner group. The evaluation will be provided for the group, and not for any individual presentation.

Partner group B:

(All prepared materials must be turned in as part of the groups evaluation.)

1. Outline technical applications for infrared photography for environmental assessment, medical diagnosis, and one of the following:

   i) military reconnaissance,
   ii) land surveys,
   iii) forensics.

   Provide at least one example for each application.

2. Using library investigation techniques, identify at least two different infrared photographs of landforms from books, maps or magazines. Provide a complete bibliography indicating the source of the photograph.

3. Identify at least one local or more global environmental problem which could be monitored by remote sensing. Explain how you would monitor the situation.

4. Design two questions which require members of the partner group to apply their understanding of the material presented.

- Library research class.

- Presentation class the teacher monitors presentations. Should any disagreement about the accuracy of the information take place, the teacher should seek the expert help of a complementary group. For example, should group A be questioned by members from group B, their conclusions can be verified by another group A. (To be a true facilitator, the teacher should try to avoid providing any expert information. The entire class may be summoned to answer a question or clarify a statement if necessary.)

- Individual tasks are assigned and write-ups are prepared.

- Partner group A is permitted 20 minutes to present gathered information. Evaluation questions are given to either individual members of group B, or the entire group.

- The same procedure is repeated for group B.

- Partner groups are provided with an evaluation form. Students from group A evaluate the effectiveness of the presentation of group B, while members of group B reciprocally evaluate the presentation by group A.

Significance

- Students are provided with an opportunity to collect data, work as a scientific research group, and pose scientific questions, evaluate outcomes and performance.

- The activity provides a means for monitoring thermal energy by infrared radiation. Many scientific principles such as heat capacity, conduction, and radiation can be reinforced during this lesson.

- Infrared photography and remote sensing devices provide a reference for investigations on the electromagnetic spectrum, which is introduced in Science 30.

- Students may be encouraged to use infrared film to carry out an environmental impact assessment. For example, Kodak produces a variety of excellent types of infrared film which can be used in conventional 35 mm cameras. (Kodak high speed infrared film 4143, Estar base, and Kodak Ektachrome Infrared film, E135-20.) Students would have the opportunity to design an experiment, and if the study be continued by classes over successive years, a local history of the area could be developed.

- Students are provided with an opportunity to discover how thermal imaging techniques help scientists formulate theories. Most importantly, the technology not only advances our understanding of ecology, but also of geography, geology, physiology, and pathology.

- A means of measuring thermal energy allows students to begin to understand why many scientists are so concerned about changing weather patterns. For example, desertification can be monitored by remote sensing satellite (Landsat) images. An understanding of why the desert is advancing in places like the Sudan can help provide needed background information for students attempting to understand why famines have become so commonplace in Northern Africa, or why the political situation in many of those countries is so unstable.

- The use of remote sensing maps enables students to investigate the world as a living ecosystem. Crop production and irrigation techniques can be studied by remote sensing. Students may use information supplied by infrared photography to question the manner in which humans appropriate land for agricultural use. Discussions about deforestation, the impact of a depleting ozone layer and increasing levels of atmospheric CO_2 can grow from an understanding of how scientists use remote sensing devices to collect data about the environment.

Evaluation

The following scales may be used.

Student Evaluation:

Mark assigned			
0	1	2	3
Work not done	Unacceptable: Minimum effort indicates either poor research or poor organizational skills. Written, oral, and/or visual communication is poor.	Acceptable Work: Shows limited evidence of research or some misconceptions are presented. Communication is acceptable; however, detail is not complete.	Very Good: Work Shows evidence of research and is organized. Communication is insightful and clear.

Teacher Evaluation:

A group mark will be assigned based on the ability of the group to achieve the following:

0 Work not done

1 Unacceptable: Minimum effort indicates either poor research or poor organizational skills. Written and visual communication is poor.

2 Acceptable Work: Shows limited evidence of research (i.e., bibliography, audio-visual, or computer-based support) or some misconceptions are presented. Written and visual communication are acceptable; however, detail is not complete. Group has experienced some difficulties with organization or sharing of tasks.

3 Very Good Work: Shows evidence of research and is organized (i.e., bibliography, audio-visual, or computer based support). Presentation indicates group has worked cooperatively and duties have been shared. Written and visual communication is insightful.

Category	1	2	3
Group A Evaluation			
• Presentation of how the technology works is accurate.			
• Bibliography of infrared pictures is provided. Facsimile of infrared picture of land form is presented.			
• Questions prepared by group demonstrate an understanding of the technological devices.			
• Group works cooperatively and group members collaborate. i. Group assumes responsibility. All group members have assigned tasks. Tasks are completed. ii. Opinions of all group members are accepted and valued. Active participation and listening skills promoted. iii. Group members treat each other with respect. Group works to consensus.			
Group B Evaluation			
• Presentation of technical applications for infrared photography is accurate.			
• An environmental problem which could be monitored by remote sensing is presented. The group describes an appropriate method for monitoring the situation.			
• Questions prepared by group demonstrate an understanding of technological devices.			

Category	1	2	3
• Group works cooperatively and group members collaborate. i. Group assumes responsibility. All group members have assigned tasks. Tasks are completed. ii. Opinions of all group members are accepted and valued. Active participation and listening skills promoted. iii. Group members treat each other with respect. Group works to consensus.			

Group Self-Rating Scales may also be used effectively – see the *Senior High Science Teacher Resource Manual*, Section 6, Assessment and Evaluation, for samples.

Any of the suggested additional investigations carried out by groups or individuals may be evaluated in the manner best suited to the particular activity.

Course of Studies

Applicable Resources inserted into the course of studies to facilitate planning • Print * AV

UNIT 2
MATTER AND ENERGY IN LIVING SYSTEMS

OVERVIEW

Science Themes: *Energy, Matter* and *Change*

In Unit 2, students investigate how *matter* and *energy* are exchanged between living systems and their environment, and examine the *changes* involved in the growth of living organisms. The energetics of diffusion, osmosis and active transport are analyzed. The limitations that diffusion places on growth, and the significance of transport in multicellular organisms are examined.

This unit builds upon Science 8, Unit 5: Growing Plants, and Unit 6: Interactions and Environments, and continues from Science 10, Unit 1: Energy from the Sun, the study of photosynthesis and respiration. The attitudes, knowledge and skills developed in this unit provide students with a sound background for the further study of living systems in Science 20 and Biology 20.

The four **major concepts** developed in this unit are:

- the cell is the basic unit of living *systems*
- growth is a major feature of living *systems*, and a major limitation to growth is the surface to volume ratio of the cell
- the cell is an open *system* exchanging *matter* and *energy* with the environment
- multicellular organisms provide for the *matter* and *energy* needs of cells at a distance from the organisms' interface with the environment.

In this unit, students will develop an ability to use the **skills** and **thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from their investigations of living *systems*.

The **STS connections** in this unit illustrate:

- the functioning of products or processes based on scientific principles
- the ways in which science advances technology and technology advances science
- the use of technology to solve practical problems.

ATTITUDES

Students will be encouraged to:

- appreciate the unity of science through the application of physical and chemical principles to biological systems
- appreciate that biological principles emerge from the investigation of the structure and function of living systems
- appreciate that many fundamental biological processes operate at both the cellular and higher levels of organization
- appreciate that the maintenance of homeostasis relies on equilibria within the organism and between the organism and its environment
- develop a curiosity to obtain a deeper understanding of biological systems
- appreciate that our knowledge of biology has been enhanced by the application of technology
- appreciate that the application of technology can have beneficial and harmful effects on biological systems.

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. The cell is the basic unit of living systems. *BioSci II *The Cell and Energy (Cellular Respiration Series) *Cell Biology *The Cytoplasm (Cell Biology Series) *Energy Flow at the Cellular Level (Energy Flow Series) *Inside the Cell *Living Textbook – Life Science *Microscope: An Indispensible Instrument *The Microscope and Its Incredible World *The Plasma Membrane	• the cell is the basic unit of living systems, by: • describing the structure of the cell membrane, nucleus, nucleoid, endoplasmic reticulum, Golgi apparatus, lysosome, vacuole, mitochondrion, chloroplast, ribosome, cytoskeleton and cell wall, where present, in bacteria, plant and animal cells • identifying the functions of the cell membrane and organelles • describing the similarities and differences in the structure and function of prokaryotic and eukaryotic cells
2. Growth is a major feature of living systems, and a major limitation to growth is the surface to volume ratio of the cell. *BioSci II *Cell Biology *Living Textbook – Life Science	• growth is a major feature of living systems, and a major limitation to growth is the surface to volume ratio of the cell, by: • describing what is meant by growth in terms of both an increase in the number of cells by fission or mitosis, and the increase in size or weight of a cell or organism • describing how the surface to volume ratio of a cell might limit its growth, and inferring the value of multicellularity in enhancing the ability to use nutrients • explaining how division of labour occurs within a single cell and, after the process of differentiation, in a multicellular organism

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• identifying cellular structures in living and prepared materials by using dissecting and compound microscopes and by examining electron micrographs	• drawing analogies between the division of labour within cells and that of the differentiation of the functional systems of the human body or of a community
• preparing plant and animal material for microscopic examination, using stains and observing the materials	• describing how developments in the technology of microscopes have led to an increase in our knowledge and understanding of cell structure
• estimating the size of cellular structures identified from a knowledge of microscope magnification power	• researching the development of the electron microscope, a Canadian invention
• observing and recording changes in growing plant cells	• describing examples of the use of bacteria in research and industrial processes
• calculating and graphing the surface to volume ratios of a variety of model cell sizes and shapes	• identifying and explaining how technological and natural systems demonstrate that surface area maximization facilitates the transfer of heat, gases, nutrients or wastes; e.g., car radiators, fish gills, intestinal villi, elephant ears, dialysis machines, aquarium pumps, heart–lung machines, alveoli, nasal membranes, capillary networks, roots and leaves
• comparing the surface to volume ratio of various organisms and relating the findings to the organisms' metabolic rate; e.g., hummingbird or shrew compared with elephant or whale	

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. The cell is an open system exchanging matter and energy with the environment. *The Biology of Water *Bio Sci II *Cell Biology *Homeostasis: The Sea Within *Living Textbook – Life Science	• the cell is an open system exchanging matter and energy with the environment, by extending from Science 8, Unit 5, the life processes of plants, and by: • describing how materials diffuse across a cell membrane in terms of concentration gradients • describing how the semipermeable nature of the cell membrane allows the process of osmosis • describing how metabolic energy may be used to do the work of transporting substances across membranes against their concentration gradients • describing, in general terms, how the energy for active transport is derived from photosynthesis and respiration in the form of adenosine triphosphate (ATP) • describing, in general terms, how the energy in light is stored in plant chloroplasts and then transferred for storage in ATP molecules • describing, in general terms, how carbon dioxide molecules in solution, or in the air, are fixed as carbohydrates in the plant chloroplasts, using the stored light energy

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• investigating the different action of a sucrose solution and a starch solution when placed in separate dialysis bags and immersed in water, and inferring why the solutions behave differently	• explaining how a dialysis machine or the process of peritoneal dialysis can be used to treat people with kidney dysfunction
• performing an experiment to demonstrate the phenomena of plasmolysis and deplasmolysis in plant cells; e.g., stamenal hairs or aquatic leaf cells, and describing the observed events in terms of the tonicity of the cells and solutions	• explaining how eating solid food can provide one with nutrition
• inferring how biochemical interconversion of starch and glucose might regulate the turgor pressure of cells	• explaining how a knowledge of diffusion and osmosis can be used in industrial applications; e.g., the desalination of sea water
• observing and diagramming the locomotion of *Amoeba* and inferring how this movement relates to the process of endocytosis and exocytosis	• describing how the ability to compress gases has enabled humans to climb high mountains and work in deep oceans
• observing and/or researching the nutrient acquisition of selected protists, plants and animals, and describing such processes with clearly labelled diagrams	• explaining what occurs when a person suffers from altitude sickness or caisson disease
	• summarizing articles from periodicals regarding the latest scientific and/or technological developments; e.g., kidney research
	• explaining how oral rehydration therapy is used to treat cholera

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
4. Multicellular organisms provide for the matter and energy needs of cells at a distance from the organisms' interface with the environment.	• multicellular organisms provide for the matter and energy needs of cells at a distance from the organisms' interface with the environment, by extending from Science 9, Unit 1, that living things show a diversity of structural adaptation, and by: • comparing and contrasting how the selected organisms transport nutrients and wastes over short and long distances, and discussing the differences in terms of the biology of the organisms • comparing and contrasting how selected organisms acquire nutrients and remove wastes, and discussing the differences in terms of the biology of the organisms • comparing and contrasting how selected organisms exchange gases, and discussing the differences in terms of the biology of the organisms.

- •Alternatives to Pesticides
- *The Fluid Transport System (Photosynthesis Series)
- •Lawn Herbicides
- *Living Textbook – Life Science
- •One Minute Readings
- *Osmoregulation (Homeostasis Series)
- *Our Environment
- •Pesticide Education Program
- •Recognizing Herbicide Action and Injury
- *The Sea Within (Homeostasis Series)
- •Using Dimethoate Safely

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• observing and describing the appearance of cytoplasmic streaming in *Amoeba* or a plant cell, and inferring similar movement in most cells of a multicellular organism • identifying diverse pairs or organisms and comparing them with respect to transport systems; e.g., *Amoeba* and giraffe, a single-celled alga and a redwood tree • observing and recording the movement of water in plants.	• drawing appropriate analogies for nutrient distribution in multicellular organisms; e.g., animal versus factory • researching and explaining how the vacuum tapping system, invented by a Canadian, takes advantage of the natural transport system of maple trees • describing how a systemic pesticide is taken up and distributed throughout a plant; e.g., the fungicide used to treat Dutch elm disease • discussing the positive and negative features of commonly used systemic pesticides.

UNIT 2 – Matter and Energy in Living Systems Lesson Exemplars

Exemplar 1 Using Technology to Learn About Plant Cells

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *matter* and *change*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *differentiating between relevant and irrelevant data or information*
- *assembling and recording background information*
- *identifying materials and apparatus required*
- *formulating questions, hypotheses and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating data more effectively, using mathematical and statistical calculations where necessary*
- *expressing measured and calculated quantities to the appropriate number of significant digits and using appropriate SI units for all quantities*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying and discussing sources of error and their effect on results*
- *identifying assumptions, attributes, biases, claims or reasons*
- *identifying main ideas*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *formulating further testable hypotheses supported by the knowledge and understanding generated*
- *relating the data or information to laws, principles, models or theories identified in background information*

- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *identifying limitations of the data or information, and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *suggesting alternatives and considering improvements to experimental technique and design*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted*
- *the inability of science to provide complete answers to all questions*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the limitations of scientific knowledge and technology*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *describing the structure of the cell membrane, nucleus, nucleoid, endoplasmic reticulum, Golgi apparatus, lysosome, vacuole, mitochondrion, chloroplast, ribosome, cytoskeleton and cell wall, where present, in bacteria, plant and animal cells*
- *identifying the functions of the cell membrane and organelles*
- *explaining how division of labour occurs within a single cell and, after the process of differentiation, in a multicellular organism*
- *describing how the surface to volume ration of a cell might limit its growth, and inferring the value of multicellularity in enhancing the ability to use nutrients*

Skills

- *identifying cellular structures in living and prepared materials by using dissecting and compound microscopes and by the examination of electron micrographs*
- *preparing plant and animal material for microscopic examination, using stains and observing the materials*
- *estimating the size of cellular structures identified from a knowledge of microscope magnification power*

STS Connections

- *describing how developments in the technology of microscopes have led to an increase in our knowledge and understanding of cell structure*
- *researching the development of the electron microscope, a Canadian invention*

Comments: This lesson is designed to show how a technological device, the microscope, provides information about cell structure, function and size.

Prior to beginning this lesson students should be able to:
a) identify the parts of a microscope
b) use low, medium and high power objectives to focus an image
c) identify structures present in plant cells

Teachers may wish to refer to Appendix A, Skills 9, 10 and 11 and Chapter 4, section 4.1 of the *Visions 1* textbook.

Timing

Approximately two 60-minute classes are required: one for the laboratory investigation and one for the development and application questions.

Introduction

Teacher shows students two extremely different plants (or pictures thereof).
OR
Teacher shows students two extremely different parts of the same plant (or pictures thereof).

Then teacher poses the following questions:
- Are all plants cells similar in structure?
- How does cell structure provide clues about function?
- How big are plant cells?

Students offer ideas. Teacher makes no attempt to answer the questions for the students, but at the end of the activity returns to these three initial questions.

Exploration

Students are given time to read the laboratory hand-out (next page). Teacher checks for understanding of procedures outlined and reviews procedure for focusing microscope. Teacher models preparation of the wet mount and proper staining technique. Teacher reminds students about routine safety and housekeeping procedures. Ideally, students should work in groups of two or three. While students are working, teacher can circulate, help students, observe and assess their performance (refer to the Evaluation section of this exemplar for a suggested evaluation matrix and checklist).

Note: The application questions should not be assigned until after the development stage of the lesson.

Development

Teacher directs class discussion to take up answers to lab. See answer key given below for suggestions.

a. Describe the appearance of the cells.
Answers will vary, but expect students to describe shape and arrangement of cells.

b. Which light intensity is most appropriate for viewing the specimen? Why?
Answer: Low light intensity, because shadows make cell parts more visible.

c. Why was the stain used?
Answer: Cell parts can be seen more clearly.

d. Diagram and label the cell. Make sure that you record only what you can see.
Answer (Note: All cells will not have a nucleus.): Students will not be able to see most cytoplasmic organelles (i.e., ribosomes, mitochondria, endoplasmic reticulum).

e. Why is it important to view a single layer of cells?
Answer: Multiple cell layers may overlap, making the identification of individual structures difficult. Cells may overlap from multiple layers, making it difficult to see cell structures.

f. Compare a cell from the specimen that you are viewing with the onion.

Characteristic	Onion	Other Plant Specimen
Placement of nucleus		
Shape of cell wall		
Chloroplasts present		
Vacuole present		
Size of cell (see part l below)		

g. Measure and record the width of the field of view by counting the number of mm markers. Estimate to the nearest 0.5 mm.
Answer: Most microscopes 4 mm for 4X objective, but answers may vary depending on microscope.

h. Convert millimetres to micrometres (µm). 1 mm = 1000 µm.

i. Record the width of the field of view.
Answer: Most microscopes 2 mm for 10X objective, but answers may vary depending on microscope.

j. Ratio quotient = $\frac{\text{magnification of high power lens}}{\text{magnification of low power lens}}$
Sample answer: Ratio quotient = 40X/4X = 10

k. Field diameter High power = $\frac{\text{low power field diameter}}{\text{ratio quotient}}$
Sample answer: Field diameter for high power = 4000 µm/10µm
= 400 µm

l. Calculate the size of the cell.
Estimate size = $\frac{\text{field diameter}}{\text{fit number}}$

Cell Size Estimate = $\frac{\text{field diameter}}{\text{estimate \# of cells to fit across field diameter}}$

(Answers will vary with each cell considered.)

Teacher refers to the three questions posed at the beginning of the lesson. Teacher directs class discussion to ensure that all students have an understanding of the answers.

Application

Teacher assigns application questions (see key given below for suggested answers) and student questions. Students may work individually or in their lab groups. Teacher can continue to circulate and carry out performance assessment while students are working. Students hand in completed lab sheets to be marked by teacher.

Application Questions

1. Which organelles cannot be seen when viewing the onion cell under the light microscope?
   Answer: Ribosomes, mitochondira, endoplasmic reticulum, lysosomes, centrioles, etc. Generally, chloroplasts and Golgi bodies are not seen. (Mark the question correct if at least two structures are mentioned.)

2. What evidence could you provide that supports the hypothesis that cells have depth or thickness?
   Answer: As the fine adjustment focus is changed, different objects become visible.

3. Explain why plant cells contain chloroplasts, yet no chloroplasts are seen in the cells of the onion bulb.
   Answer: The bulb of the onion is not exposed to light. Chloroplasts need light.

4. Why are scientists interested in recording the size of cells?
   Answer: This question is designed to promote lateral thinking. Accept a variety of different answers. The question is designed to act as a springboard for the discussion of why the cells in the meristematic region of a root tip, the area of active cell division, are smaller than the elongated cells, characteristic of mature cells which are not dividing rapidly. The relationship of cell volume to surface area can be introduced by this question. Smaller, more active cells have greater surface area to cell volume, and therefore tend to be more successful at absorbing essential nutrients required to sustain rapid cell growth.

5. A student suggests that the shape of a cell is affected by the stain used. How would you go about checking this hypothesis?
   Answer: This question is designed to promote hypothesis testing. Accept a variety of different answers. Student might check the cell before and after the stain is added. Different metabolic activities may be measured before and after the stain is added.

6. A scientist attempts to transplant a chloroplast from algae into a small aquatic animal. Formulate a testable hypothesis regarding the survival advantage this animal would have over other members of its species. State your rationale (reason).
   Answer: The new animal would be better equipped to survive adverse conditions because it could make its own food.

Student Questions

After completing this laboratory investigation, you probably have questions about microscopy and plant cells. In the space provided below write two or three of these questions.

Significance

Connections of Science and Technology with Nature of Science

Students have an opportunity to view cells and collect data. Quantitative measurements, such as determining cell size, provide an example of how technology advances scientific information. The laboratory also provides a vehicle for students to appreciate the limitation of scientific knowledge that is rooted within the limitations presented by the technology. For example, many cell structures that they have studied are not visible under the light microscope. The question as to whether the cells viewed under the microscope behave like normal cells within the intact onion, may be raised.

- The effects of over-fertilizing can be used as a practical example for linking cell structures with osmosis. The microscope provides a tool for investigating how the cell changes.

- The effects of heavy metals or acid deposition on cell structure can also be studied with the aid of the microscope.
- The techniques developed in the laboratory can be used to differentiate cancer cells from normal cells. Cancer cells tend to have an enlarged nucleus and, therefore, a greater nucleus to cytoplasm ratio.
- The development and use of the electron microscope can be researched. If available, electron micrographs can be examined and compared to images seen through the compound microscope.

Connections of Science and Technology with Societal Issues

Students can apply the techniques developed in the laboratory to study how acid deposition affects cells. Why are some cells more sensitive to acid deposition? Some of the answers can be uncovered through investigation. The ability and responsibility that society has to protect the environment can be emphasized. The *Visions 1* textbook's "Technology" features in Chapter 4 offer additional examples.

Suggested Evaluation Matrix for Summative Assessment

Activity / Score	Laboratory Investigation Skills (see skills framework given in Overview)	Participation	Product – Lab Questions and Application Questions
5	Understands investigation Selects necessary strategies Completes correctly Evaluates appropriateness of methods used	Gets involved quickly Stays involved	Complete Correct Neatly done "Commands respect"
4	As above, but fails to evaluate methods used	Needs a push to start Stays involved	Mostly complete Correct Neatly done "Good work"
3	Errors evident, but strategies selected led to acceptable results	Needs periodic reminding to stay on task	Somewhat complete Minor errors Legible "Satisfactory"
2	Errors evident No results	Needs constant reminding to stay on task	Incomplete Major errors Untidy "Unsatisfactory"
E	Acceptably excused from assignment		
0	Not done or not handed in		

A checklist such as the following could be used for formative assessment. Refer to the *Senior High Science Teacher Resource Manual*, Section 5, for more information on performance evaluation.

Checklist

Student: **Date:**

_____1. Likes to solve problems

_____2. Works cooperatively with others in the group

_____3. Contributes ideas to group problem solving

_____4. Perseveres – sticks with a problem

_____5. Tries to understand what the problem is about

_____6. Can deal with data in solving problems

_____7. Thinks about which strategies might help

_____8. Is flexible – tries different strategies if needed

_____9. Checks data and/or results for accuracy

_____10. Can describe or analyze results – come to an appropriate conclusion or decision

Other Suggestions

After researching the development and use of electronmicroscopes, students could be challenged to draw and label an "electron micrograph" of either the onion cell or the other specimen they viewed.

Appropriate questions from the *Visions 1* textbook could be assigned and marked.

Students could be asked to comment (orally or in writing) on the following statement, "There is no such thing as a typical plant cell."

STUDENT HANDOUT

Laboratory Investigation: Viewing Plant Cells Under the Microscope

Purpose

- To investigate the structure of plant cells.
- To compare cells from different plants.
- To determine the size of plant cells and cell components.

Materials

Methylene blue or iodine stain	scalpel
microscope slides	medicine dropper
glass coverslips	forceps
lens paper	Spanish onion bulb
flat toothpick	squash or other vegetable
paper towel	

Procedure

Part 1: Viewing plant tissue

1. Clean your microscope lenses, slides and coverslips with lens paper before beginning.
2. Obtain a section of a scale leaf from the onion bulb by cutting a 2 cm^2 piece.
3. Remove a single layer of surface cells from the inner side of the scale leaf. Forceps can be used to remove the cell layer.
4. Place the onion tissue on a microscope slide and add two drops of water. Care should be taken to spread the tissue on the slide. **Caution: Avoid folding one cell layer over another.**
5. Holding the coverslip between the thumb and index finger, touch the surface of the slide at an angle of 45 degrees.
6. Gently lower the coverslip onto the onion tissue, allowing the air to escape.
7. If air bubbles are present, gently tap the coverslip with a pencil to remove them.
8. Place the slide on the microscope stage and focus the cells under low power magnification. Use the coarse adjustment focus.
9. Adjust the slide so that the cells are in the centre of the field of view. Switch to medium power objective and focus with the fine adjustment focus. The diaphragm should be opened to allow the maximum amount of light through the condenser.

   Q. Describe the appearance of the cells.

   _____

10. Slowly, reduce the light intensity by closing off the diaphragm and observe the image.

Q. Which light intensity is most appropriate for viewing the specimen ? Why?

_____

_____

11. Remove the slide from the stage of the microscope. Place a drop of stain (iodine or methylene blue) on one side of the coverslip. Touch the opposite side of the slide with a piece of paper towel. This should draw the stain under the coverslip.

12. Wipe off any excess fluids from the slide and place the slide on the stage. Locate the cells first under low and then under medium power magnification.

Q. Why was the stain used?

_____

13. Rotate the revolving nosepiece to high magnification and focus on a single cell (**keep the slide for future reference**).

Q. Diagram and label the cell. Make sure that you only record what you can see.

Part 2: Comparing plant tissues

14. Your teacher will supply you with another plant in order to compare cell shapes. This plant does not have a thick outer covering that is easily extracted.

15. **Discuss the procedure that you will use to examine this new specimen, first with your laboratory partner and then with your teacher.**

    Q. Why is it important to view a single layer of cells?

    _____

    _____

16. View the specimen first under low power and locate an appropriate group of cells. Then focus under high power magnification.

    Q. Prepare and then fill in a comparison table for the following characteristics of the onion and the other specimen: placement of nucleus, shape of cell wall, presence of chloroplasts, presence of vacuoles, size of cell (see Part 3 of lab).

    _____

    _____

    _____

    _____

    _____

    _____

Part 3: Determining field diameter and size of the cell

17. Return the nosepiece to low power magnification. Place a clear plastic ruler on the microscope stage and focus on the millimeter divisions along the edge of the ruler.

    Q. Measure and record the width of the field of view by counting the number of mm markers . Estimate to the nearest 0.5 mm.

    _____

    Q. Convert millimeters to micrometers (μm). 1 mm =

    _____

18. Rotate the nosepiece to medium power magnification. Use the fine adjustment and locate the mm markers.

    Q. Record the width of the field of view.

    _____

    Caution: Do not use the high power lens for this procedure (the high power objective may be scratched by the ruler).

19. The field of view for high power magnification can be determined indirectly by calculating the ratio quotient of the high powered objective lens to the low powered objective lens.

    Q. Ratio quotient = $\frac{\text{magnification of high power lens}}{\text{magnification of low power lens}}$ = _____ =

20. Calculate the field diameter for the high power objective. (Use μm for field diameter.)

Q. Field diameter = $\frac{\text{low power field diameter}}{\text{ratio quotient}}$ = _____ =
High power

21. Estimate the number of times the cell appears to fit across the field of view. (fit number)

Q. Calculate the size of the cell.

Estimate size = $\frac{\text{field diameter}}{\text{fit number}}$ = _____ =

Application Questions

1. Which organelles cannot be seen when viewing the onion cell under the light microscope?

2. What evidence could you provide that supports the hypothesis that cells have depth or thickness?

3. Explain why plant cells contain chloroplasts, yet no chloroplasts are seen in the cells of the onion bulb.

4. Why are scientists interested in recording the size of cells?

5. A student suggests that the shape of a cell is affected by the stain used. How would you go about checking this hypothesis?

6. A scientist attempts to transplant a chloroplast from algae into a small aquatic animal. Formulate a testable hypothesis regarding the survival advantage this animal would have over other members of its species. State your rationale (reason).

Exemplar 2 Establishing a Pesticide Policy for the Town of Greenburg

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *energy, matter* and *change.*

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *differentiating between relevant and irrelevant data or information*
- *assembling and recording background information*
- *formulating questions, hypotheses and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem.*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *accurately observing, gathering and recording data or information according to safety regulations (e.g,. WHMIS) and environmental considerations.*

Organizing and Communicating

- *organizing and presenting data (themes, groups, tables, graphs, flowcharts and Venn diagrams) in a concise and effective form*
- *communicating findings of investigations in a clearly written report.*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying assumptions, attributes, biases, claims or reasons*
- *identifying main ideas.*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *identifying further problems or issues to be investigated*
- *identifying alternatives for consideration*
- *proposing and explaining interpretations or conclusions*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *answering the problem investigated*
- *summarizing and communicating findings*
- *deciding on a course of action*

Evaluating the Process or Outcomes

- *establishing criteria to judge data or information*
- *considering consequences and perspectives*

- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *evaluating and assessing ideas, information and alternatives.*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted*
- *the inability of science to provide complete answers to all questions*
- *the functioning of products or processes based on scientific principles*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the limitations of scientific knowledge and technology*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations.*

Specific Learner Expectations

Knowledge

- *identifying the functions of the cell membrane and organelles*
- *describing how materials diffuse across a cell membrane in terms of concentration gradients*
- *describing how the semipermeable nature of the cell membrane allows the process of osmosis*
- *describing how metabolic energy may be used to do the work of transporting substances across the membrane against their concentration gradients*
- *comparing and contrasting how selected organisms transport nutrients and wastes over short and long distances, and discussing the differences in terms of the biology of the organisms*
- *comparing and contrasting how selected organisms acquire nutrients and remove wastes, and discussing the differences in terms of the biology of the organisms*
- *comparing and contrasting how selected organisms exchange gases, and discussing the differences in terms of the biology of the organisms.*

Skills

- *observing and/or researching the nutrient acquisition of selected protists, plants and animals, and describing such processes with clearly labelled diagrams*
- *identifying diverse pairs of organisms and comparing them with respect to transport systems; e.g., Amoeba and giraffe, a single-celled alga and a redwood tree*
- *observing and recording the movement of water in plants.*

STS Connections

- *identifying and explaining how technological and natural systems demonstrate that surface area maximization facilitates the transfer of heat, gases, nutrients or wastes; e.g., roots and leaves*
- *describing how a systemic pesticide is taken up and distributed throughout a plant; e.g., the fungicide used to treat Dutch elm disease*
- *discussing the positive and negative features of commonly used systemic pesticides.*

References

The following references are recommended for both student and teacher use to supplement the relevant information provided in the *Visions 1* textbook, Chapters 4, 5, and 6.

1. Marean, John et al. *Issues for Today.* GLC Publishers, 1985.
2. Simonson, Gayle. *Mosquito Kit.* Alberta Environment.
3. Simonson, Gayle. *Forest Tent Caterpillar Study.* Alberta Environment.
4. Simonson, Gayle. *Pesticide Education Unit.* Alberta Environment.

These three are available free from the Education Branch of Alberta Environment
Telephone: 427–6310

Comments

This lesson presents a Science-Technology-Related Social Issue. Students are asked to apply knowledge acquired within Unit Two to construct a policy governing the use of pesticides for "their" town, Greenburg. A role-playing lesson format is used.

Training

Approximately 20 minutes are required to set up the role-playing scenario. The scenario is composed of two essential parts: a presentation of spraying policies to town council members by various interest groups, and the formulation of a policy governing the use of pesticides. The presentations and policy formulation can take place two class periods following the initial instructions as students will require one class period to research pesticides using the recommended references.

Allow 35–40 minutes for the presentations and questions by town council members. A minimum of 15–20 minutes should be set aside for town councillors to formulate a pesticide policy.

Introduction

The following demonstration is set up one day prior to the lesson. No explanation is given.

Materials

2 white carnations
scissors
water spray bottle
2, 100-mL beaker
blue or red food colouring

Procedure

1. Using the scissors, cut the stem of the white carnation to approximately 20 cm.
2. Fill both 100 mL beakers with tap water. Add enough food colouring to one of the beakers to produce a deep colour.
3. Place the carnations in each of the beakers.

Teachers may wish to assign the reading of sections 6.2 and 6.2 in the *Visions 1* textbook as homework.

Exploration

The following day.

Teacher Activities	Student Activities
• "Describe your observations."	• Students note that the carnation placed in the beaker with food colouring changed colour.
• "Why did the carnation placed in the blue/red water absorb the food colouring?"	• Discussion of water movement in xylem vessels.
• Teacher places water and food colouring in spray bottle and sprays the white carnation. Students are asked to describe their observations.	• Students note that the coloured water droplets sit on top of the flower.
• Teacher asks students to think of a technological application for the demonstrations. Hints may be provided to direct the conversation toward pesticides.	• Students begin discussing pesticides.
• Teacher challenges students to use their observations of the foregoing demonstrations to explain how pesticides are absorbed and transported by plants.	• Students propose explanations.
• Teacher may wish to encourage lively open class discussion of pesticide use as a foreshadowing of the role-playing activity which follows.	• Students express divergent views on pesticide use.

Development

Teacher directs class discussion to:

- define pest, pesticide, herbicide, fungicide, insecticide
- explain how a systemic pesticide is taken up and distributed throughout a plant
- compare systemic pesticides and pesticide sprays
- state that pesticides function by disrupting the metabolic activities of the pest's cells
- list the main positive and negative features of (systemic) pesticides
- define biological control.

Application

Teacher Activities

- Teacher introduces following scenario

  The Town Council of Greenburg must establish a pesticide policy. However, before a policy can be established, various interest groups present their concerns in a town forum. Mayor will be appointed to run the town council. Each interest group is given three minutes for presentations. City council members are given an additional three minutes to question the presenter.

- Teacher defines the specific assignment for each student. Each identified role may be assigned to groups of two or three students.

- All members of the interest group are required to supply individual briefs outlining their concerns. Remind students to present the viewpoints of their characters, not their own. The briefs should be at least one page. Town council members are asked to draft proposed legislation. (Each town councillor may be asked to submit the legislation individually or work through the legislation as a group.)

- Teacher hands out the Interest Group Information Sheets (p. 25, 26, 27).

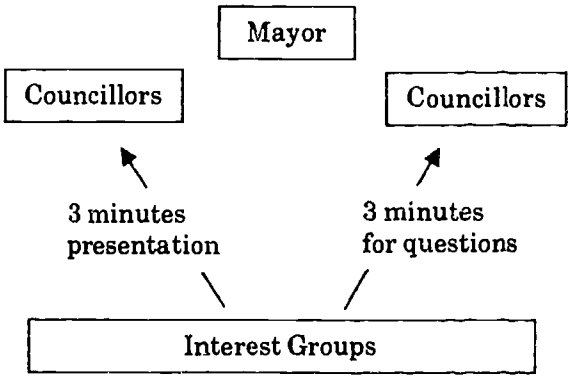
- Teacher may wish to create an additional group such as a newspaper/radio/T.V. reporting team which could write about/ tape record or video record the proceedings of the town council meeting.

Student Activities

- Students sign up as a member of a particular interest group or a member of town council. All groups are required to do some initial research on pesticides.

- Students begin research using the recommended references.

- Interest group members prepare briefs. Council members and investigative reporters collect and record background information and prepare questions to ask the interest group members.



Interest Group Information Sheet

"Chemical Sprays" Interest Group – Point of View – Concerns

Water soluble and oil soluble sprays have had a long history. Although some insecticides, herbicides and fungicides have caused problems, this group believes that the only effective way of controlling pests is by spraying. Currently, more than 75% of all pesticides are released in the form of sprays. Large areas can be sprayed economically. It is important to note that mosquitoes, tent caterpillars, spruce budworm, and most other insect pests are controlled by spraying. Farmers and gardeners rely on sprays to control weeds, bacteria and fungi. Because some insects, like mosquitoes, travel great distances, this group believes that the only effective way of controlling the pest is by large-scale spraying. Similarly, harmful spores from disease causing fungi, and seeds from noxious weeds are capable of travelling great distances. Herbicides that control can be sprayed over large areas, thereby limiting the success of the noxious weeds.

Members of the Chemical Sprays Interest Group

Mr/Ms (use student's name)

- plant manager of a large chemical plant that produces pesticides
- a number of families depend on the income derived from the production of pesticides

Mr/Ms (use student's name)

- homeowner in the town
- concerned about the many weeds from the nearby big city which invade his/her perfect lawn

Mr/Ms (use student's name)

- concerned about the large number of mosquitoes in the area
- a marsh area west of the big city has been creating problems for years
- unfortunately, this marsh area is not part of the town
- are young parents worried about the number of mosquito bites suffered by their children

Mr/Ms (use student's name)

- concerned about keeping tent caterpillars and other pests under control
- two years earlier a tent caterpillar infestation devastated many poplars in the town
- tourists will not stay in a town where tent caterpillars have devastated the vegetation

Interest Group Information Sheet

"Systemic Pesticides" Interest Group – Point of View – Concerns

This group believes that contact sprays are dangerous because they are not selective. How can we be sure that we are killing only the pests? Systemic pesticides are absorbed by the plants and transported by vessels to the growing parts of the plant. Some of the systemic pesticides are applied to the soil to be slowly absorbed by the roots of the plants, while others such as Cygon ™, are applied to the bark. Systemic pesticides have been used successfully to control diseases such as Dutch elm disease. Unlike the sprays, the systemic pesticides tend to be distributed uniformly by the plant at risk, while reducing environmental contamination. One group of systemic pesticides, the Oxanthins, inhibits the action of an important enzyme of certain fungi. Another group of systemic fungicides, called Benomyls, interferes with DNA replication in a wider group of fungi that cause powdery mildew and apple scab. A formidable fungus causing Dutch elm disease is controlled by the injection of a hydrochloric salt into the trunks of diseased trees.

Members of the Systemic Pesticides Interest Group

Mr/Ms (use student's name)

- does not believe in the use of sprays
- suspects that his/her cat was affected by eating grass treated with a spray herbicide
- did lose a large tree to Dutch elm disease a few years ago and therefore favours the use of systemic fungicides

Mr/Ms (use student's name)

- does not believe in the use of sprays
- is concerned about the neighbour who sprays his tree with malathion to kill aphids. He/she is aware of the harmful side effects of malathion
- is worried that some of the pesticide sprays have drifted into his/her child's open window
- believes that systemic pesticides pose no serious risks to people and, therefore, insists that the systemic pesticides should be used

Interest Group Information Sheet

"No Pesticides" Interest Group – Point of View – Concerns

This group believes that any attempt to control nature will lead to catastrophe. DDT and the harmful side-effects of agent orange are given as examples. Although they realize that food production may decrease, they also believe that foods will be healthier.

Members of the No Pesticides Interest Group

Mr/Ms (use student's name)

- believes that systemic pesticides are better than sprays but is concerned that systemic pesticides may kill soil microbes
- believes that the soil is not a combination chemical but a living ecosystem containing essential decomposers
- is concerned about the possibilities of pesticides entering the water table

Mr/Ms (use student's name)

- believes that people may not use pesticides correctly
- claims that even systemic pesticides may be sprayed over a large area, simply because it is a faster method of control
- believes that since we cannot guard against pesticide misuse, we should ban them altogether
- knows that biological control methods do exist
- believes that in the long run biological control methods will be cheaper

Significance

Connections of Societal Issues With Nature of Science

Inextricably tied with the application of pesticides is an understanding of how they affect cells of plants and animals. The absorption of the specialized poisons and the effect upon cellular metabolism provide the scientific underpinnings for understanding the technology. The pesticide study places a study of the cell within a natural ecosystem. The large number of variables and the inability of scientists to account for all of the combinations of factors help the student understand why scientists do not provide definitive answers to many of the questions.

Connections of Societal Issues With Science and Technology

Although a social issue provides the initial focus for the activity, no discussion of the environmental, health, or economic risks associated with restricting or encouraging the use of pesticides can begin without an understanding of the technology. The limits of the pesticide technology enable the student to understand what the technology can and can't do.

Study of the pesticides also provides direct review of material learned in Unit One and may be used as a springboard (introduction) to Unit Three.

Evaluation

1. A group mark or an individual mark may be assigned, based on the ability of students to illustrate a progression of scientific thought during the Town Council Meeting.

   The same holistic marking scale may be used for both written and oral presentations. A mark of 1 indicates minimal effort, while a 3 is an average mark. A five indicates exceptional effort. (Refer to Overview for specific skills and concepts.)

Category	1	2	3	4	5
1. Research, content					
2. Quality of expression, grammar and word usage					

Other Suggestions

- Ask students to reflect on their individual and group feelings and performance during the mock Town Council Meeting (a videotape of the proceedings could be shown first).
- Ask students to compare their own views with those expressed by their character in the role-playing simulation (orally or in a written paragraph).
- Ask students to evaluate the pesticide-use policy proposed by the Town Council.
- Challenge students to write an **unbiased** report (1–2 pages) outlining the difficulties encountered in establishing a pesticide policy that satisfies all interested parties. (The report should be based on the research students did prior to the Council Meeting, as well as information acquired during the meetings.)
- Challenge students to formulate a pesticide-use policy for their school/municipality/province.

Course of Studies

Applicable Resources inserted into the course of studies to facilitate planning • Print * AV

UNIT 3
MATTER AND ENERGY IN CHEMICAL CHANGE

OVERVIEW

Science Themes: *Energy, Matter* and *Change*

In Unit 3, students investigate how *matter* and *energy* are involved in chemical change. Students study the patterns among the properties of the elements that form the basis of the periodic table. A simple model of the atom is presented to explain the chemical properties of *matter* and the *energy* effects of chemical *change*. To deal with the vast array of compounds created by combining elements, a system of chemical nomenclature is introduced.

This unit builds on Science 8, Unit 1: Solutions and Substances; and Science 9, Unit 5: Chemical Properties and Changes, and provides students with a foundation for the further study of chemical change in Science 20 and Chemistry 20.

The five **major concepts** developed in this unit are:

- *matter* is classified on the basis of its properties
- *matter* has a well defined underlying structure
- elements combine to form a vast array of compounds
- *energy* is involved in each *change* that *matter* undergoes
- *matter* is conserved in chemical *changes*.

In this unit, students will develop an ability to use the **skills** and **thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from their investigations of chemical *change*.

The **STS connections** in this unit illustrate:

- the ways in which science advances technology and technology advances science
- the influence of the needs, interests and financial support of society on scientific and technological research
- the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations.

ATTITUDES

Students will be encouraged to:

- appreciate the orderliness of nature and the characteristic pattern in the properties of matter
- appreciate that careful and precise observations form the basis for generalizations about the nature of matter
- tolerate the uncertainty in our explanations of the nature of matter
- value the contribution of science and technology to our understanding of the nature of matter
- value the need for safe handling and disposal of chemicals
- demonstrate an awareness of the impact that humans have had on the environment through the manipulation of matter for personal and industrial use
- appreciate the benefits that have resulted from applications based on chemical principles.

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. Matter is classified on the basis of its properties.	• matter is classified on the basis of its properties, by extending from Science 8, Unit 1, and Science 9, Unit 5, the major categories of matter (e.g., pure substance, mixture, element, compound, solution) and the differences between physical and chemical properties, and by: • explaining that matter is everything that has mass and occupies space • explaining the classification of elements in the periodic table in terms of chemical properties • predicting the properties of elements from their position on the periodic table, and the placement of elements on the periodic table from their properties • identifying the elements that are most prevalent in living systems
2. Matter has a well defined underlying structure.	• matter consists of atoms, ions and molecules, by: • providing definitions for the following chemical species: atoms (isotope, radioisotope), ions, molecules • indicating the relative sizes of chemical species compared to microscopic and macroscopic species • describing the extent to which we are able to observe chemical species with modern technology

*Chemistry at Work
*CRC Handbook of Hazardous Laboratory Chemicals
*Get the Lead Out (Challenge Journal Series)
•A Guide to WHMIS
•Introducing WHMIS
*Lab Safety – Accident at Jefferson High
*Living Textbook – Physical Science
•One Minute Readings
*Our Environment
*Periodic Table (World of Chemistry Series)
*Periodic Tables and Periodicity
•Understanding Our Environment
•WHMIS: When you see these symbols
•WHMIS: Hazard Symbols
*WHMIS – Working for You

*Atom (World of Chemistry Series)
*Chemistry at Work
*The Earliest Models
*Living Textbook – Physical Science
•One Minute Readings
*Our Environment
*Reactions/Driving Forces (World of Chemistry Series)

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• handling reactive materials safely	• describing how WHMIS symbols are used to classify potentially hazardous materials
• using common separation techniques, such as filtration, extraction, distillation and chromatography	• describing some of the physiological effects of heavy metals, such as lead and mercury, and the possible sources of contamination in everyday life
• using observation and experimentation to study the properties of matter, and to classify various examples of matter	• explaining why most metals must be separated from their ores and protected to prevent corrosion
• observing chemical and physical properties of representative elements, noting the patterns	
• building models of the structure of the atom, including protons, neutrons and electrons—their relative size, charge, mass and position	• illustrating, with examples, how radioactive substances are used in medical research and treatment
	• discussing the merits of spending public money on investigating atomic structure

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. Elements combine to form a vast array of compounds. •Alberta's Special Waste Management System *Chemistry at Work •Don't Give Hazardous Wastes a Home •Envirodial •Environmental Choice Factsheets •Environmental Issues: Waste Management *Living Textbook – Physical Science •One Minute Readings *Our Environment *Our Throwaway Society *Toxic Waste – Perspectives in Science	• elements combine to form compounds that have characteristic properties and are assigned individual names, by: • differentiating, on the basis of properties (conductivity, pH, etc.), among ionic and molecular compounds, including acids and bases • identifying the role of several compounds in living systems • naming and writing formulas for selected ionic and molecular compounds, including acids and bases
4. Energy is involved in each change that matter undergoes. *Acid Rain: A North American Challenge •Acidic Deposition •Alberta's Clean Air Act *Assault on the Ozone Layer •Atlas of Environmental Issues *Atmosphere (World of Chemistry Series) *Atom (World of Chemistry) *Chemical Reactions *Chemistry at Work *Decomposition and Synthesis – 2 Sides to Reaction Chemistry •Destination Conservation *Energy Flow in the Biosphere (Energy Flow Series) *Environment (Science Show Series) *Global Warming (Climate and Man) *Global Warming: Hot Times Ahead *Greenhouse Effect (Climate and Man) *Living Textbook – Physical Science •One Minute Readings *Our Environment *Our Throwaway Society *Ozone (Planet Under Pressure Series) •Somebody Should Do Something About This *Swirling Seas •Understanding Our Environment	• energy is involved in each change that matter undergoes, by: • comparing and contrasting physical, chemical and nuclear changes • differentiating between endothermic and exothermic changes • identifying types of chemical reactions; e.g., formation, decomposition, combustion, replacement • writing word equations for chemical reactions that occur in living and non-living systems

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• investigating the properties of representative ionic and molecular compounds, including acids and bases, in laboratory experiments and in resources, such as a chemistry handbook	• listing several common compounds that are essential to human health
• using equipment, such as Bunsen burners and laboratory glassware, correctly and safely	• listing several common compounds that are hazardous to human health and the environment
• handling and disposing of chemicals in a safe, responsible manner	• discussing the disposal problem related to used materials
	• outlining safe methods for handling hazardous substances in the home
• performing experiments that illustrate chemical changes	• providing examples of processes that use physical and/or chemical changes to produce useful substances and energy
	• identifying chemical reactions that are harmful to the environment; e.g., destruction of the ozone layer by chlorofluorocarbons, formation of acid rain and greenhouse gases

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:

5. Matter is conserved in chemical changes.	• the conservation of mass in chemical changes can be illustrated and quantified, by:
	  • outlining experiments, such as van Helmont's and Lavoisier's, investigating mass changes in chemical reactions
	  • writing chemical equations that include the state of matter for each substance, and balancing the equations in terms of chemical species and moles.

*Chemistry at Work
*The Earliest Models (Structure of the Atom Series)
*Living Textbook – Physical Science
*Mole (World of Chemistry Series)

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• performing an experiment that demonstrates the principles behind Lavoisier's experiments on combustion, which led to the conclusion that burning substances gain mass by combining with oxygen from the air	• explaining the use of balances in analytical chemistry
• illustrating, through measurements and calculations involving moles and molar masses, that matter is conserved in chemical changes.	• using a calculator for calculations involving moles.

UNIT 3 – Matter and Energy in Chemical Change Lesson Exemplars

Exemplar 1 Elements and the Periodic Table

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *diversity* and *matter*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *preparing required observation charts or diagrams*

Collecting and Recording

- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *relating the data or information to laws, principles, models or theories identified in background information*

Evaluating the Process or Outcomes

- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *summarizing and communicating findings*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge and the way in which proposed theories may be supported, modified or refuted*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *explaining the classification of elements in the periodic table in terms of chemical properties*
- *predicting the properties of elements from their position on the periodic table and the placement of elements on the periodic table from their properties*
- *naming and writing symbols for the first 20 elements and other common elements*
- *identifying the elements that are prevalent in living systems*

Skills

- *observing chemical and physical properties of matter, noting patterns*

STS Connections

- *listing some elements that are hazardous to human health and the environment*
- *describing some of the physiological effects of heavy metals such as lead and mercury and the possible sources of contamination in everyday life*

Introduction

Use the story of how Mendeleev developed the periodic table to provide students with a sense of the way in which this scientific knowledge developed. Teachers with a flair for the dramatic might consider dressing up as Mendeleev and presenting this as a monologue, using a set of "element cards" as a prop. For more information on Mendeleev than is contained in the student text, refer to Bronowski's *Ascent of Man* or Asimov's *History of Physics*.

Exploration

Students research, using a basic chemistry textbook, the properties of elements from the major groups to illustrate the periodic trends.

Development

Through a class discussion students are helped to develop the following concepts:

- There are inherent patterns and order in nature.
- Scientific discoveries require the power of observation, creativity, imagination and perseverance; social factors often play a role in the acceptance of new ideas.
- Elements are the simplest form of matter from which the diverse array of materials in the world are formed.
- Elements have individual names and symbols to facilitate communication.
- Periodic law states that when elements are arranged in order of increasing atomic number, there is a periodic repetition of their properties.
- The organization of the elements in the periodic table allows for prediction.
- The physical and chemical properties of elements can be studied in the laboratory and are documented in reference sources.

Application

Students do Activity 7.4: Explaining Metals and Nonmetals

Students view a film or video describing the major element groups, e.g., Chemstudy film: *Chemical Families* or Periodic Table (World of Chemistry Series – see Resources section, S.5).

The following concepts from other sections of the unit will be required for understanding:

- elements consist of atoms with a fixed number of protons and electrons
- elements join to form compounds when electrons are transferred or shared
- the atomic number of an element refers to the number of protons in the nucleus of its atoms
- the atomic mass of an element is the weighted average of the atomic masses of the individual isotopes

The new learning may be used to reinforce the concept from Units 1 and 2, i.e., "Elements cycle through the living and non-living world."

Significance

Students investigate elements that are most significant, personally; for example:

- those that are essential to the proper functioning of the human body (Na, K, Ca, P, O, etc.). Refer to books on nutrition or ask the food sciences teacher for sources.
- those that are most economically significant (Au, Ag, Pt, Fe, Al, etc.). Refer to an atlas or ask the social studies teacher for sources, Issue 32 in *One-Minute Readings*.
- heavy metals that may be a threat to our personal health or the environment (Pb, Hg, Cd, etc.).

Refer to a text of environmental studies, current issues of science magazines, newspaper articles.

Evaluation

1. Quizzes and Exercises

   - provide names and symbols of selected elements
   - list names and properties of the major groups (1, 2, 17, 18)
   - place element symbols on a blank periodic chart from descriptions of properties

2. Activities

   - ask for a written report of Activity 7.4
   - observe students while they perform the activity, using a skills checklist to assign marks (refer to skills framework)
   - provide students with unidentified samples of elements to categorize, providing marks for correct procedures and identification

3. Investigations

   - have students prepare a written or oral report on a significant element

Exemplar 2 Structure of the Atom

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *matter, energy* and *change.*

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *differentiating between relevant and irrelevant data or information*
- *assembling and recording background information*
- *preparing required observation charts or diagrams*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating data more effectively, using mathematical and statistical calculations where necessary*

Connecting, Synthesizing and Integrating

- *relating the data or information to laws, principles, models or theories identified in background information*
- *summarizing and communicating findings*
- *deciding on a course of action*

Evaluating the Process or Outcomes

- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design proceses or methods used*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted*
- *the limitations of scientific knowledge and technology*
- *the inability of science to provide complete answers to all questions*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *providing definitions for the following chemical species: atom (isotope, radioisotope), ionic species, molecule*
- *indicating the relative sizes of chemical species compared to microscopic and macroscopic species*
- *describing the extent to which we are able to observe chemical species with modern technology*

Skills

- *building models of the structure of the atom including protons, neutrons and electrons, their relative size, charge, mass and position*

STS Connections

- *investigating radioactive substances*
- *discussing the merits of spending public money on investigating atomic structure*

Introduction

The concept of atomic radiation can be used to establish evidence of an internal structure to the atom.

Play "What Is It?" with students. Provide clues to lead the students to identify radiation (radioactivity). For example:

"It's invisible"
"It occurs naturally or can be produced artificially"
"It's been used for great benefit and for great harm"
"It was discovered accidentally by Henri Becquerel"
"Both Marie Curie and her daughter Irene Curie-Joliet won Nobel prizes for research related to it"
"Exposure to it can cause genetic defects"
"Exposure to it can reveal the structure of the skeleton and teeth"
"It's the fallout from a nuclear bomb explosion"
"It's the reason Chernobyl cannot be safety inhabited"
"It has been said that it could revolutionize the food preservation industry."

Exploration

Pose these questions for students to investigate: "What is the source of radiation?"
"What is the internal structure of the atom that results in radiation?"

Students do Activity 7.5: Communicating Information About Atoms *(Visions 1)*.

Development

Through a class discussion of the models proposed by students, ideas about atomic structure, size and energy can emerge. Help students place atomic size in perspective by using analogies such as:

- if humans were the size of atoms, Earth's entire population would fit on the head of a pin

- to see an oxygen atom as a speck it would have to be magnified 1 million times; in contrast, a blood cell would appear as a speck at 50 times magnification. (Note: the diameter of an oxygen atom is 1.2×10^{-10} metre.)

Application

Describe the modern model of the atom, discussing how this model has changed over time. A brief section is in *Visions 1*, but teachers may wish to obtain more background knowledge from a basic chemistry book.

Students do Activity 7.6 Building a Model of the Atom *(Visions 1)*. Extend the atomic model to models of ions, ionic compounds and molecules. Compare this activity to Building a Model of a Cell. Ask students where atoms, ions and molecules fit into the structure of the cell.

Significance

Perform a risk/benefit analysis on the use of nuclear fission for energy. (Reference: Issues 35, 72 *One-Minute Readings: Issues in Science, Technology, and Society*.)

Discuss the value to society of continued research into the structure of the atom, considering the high cost of building cyclotrons.

Evaluation

1. Quizzes and Exercises
   - draw and correctly label a model of the atom
   - describe the relative sizes and characteristics of protons, neutrons, electrons, atoms, ions, ionic compounds and molecules

2. Activities
   - provide a mark for the model of the atom built by the student in Activity 7.6

3. Investigations

   - carry out a "fishbowl" debate in which half the class debates while the other half evaluates the debaters using a checklist provided by the teacher (see skills framework) or developed in collaboration with students.

Exemplar 3 Acids and Bases

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *matter* and *change*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *formulating questions, hypotheses, and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*

Analyzing

- *identifying and discussing sources of error and their effect on results*

Connecting, Synthesizing and Integrating

- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *suggesting alternatives and considering improvements to experimental technique and design*

*The **STS connections** emphasized are:*

- *the functioning of products or processes based on scientific principles*
- *the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *differentiating, on the basis of properties, between acids and bases*
- *identifying the role of acids and bases in living systems*
- *naming and writing formulas for selected acids and bases*

Skills

- *investigating the properties of representative acids and bases in laboratory experiments and in resources such as a chemistry textbook*

STS Connections

- *outlining safe methods for handling and disposing of acids and bases*

Introduction

Have students work in groups to prepare a spidergram or concept map around "acids and bases." This should serve two purposes: to make students aware of the relevance of acids and bases in their lives, and inform the teacher of their knowledge base.

Perform the "water into wine" demonstration.
- fill a wine glass with a weak sodium hydroxide solution
- place several drops of phenolphthalein solution in the bottom of another wine glass, out of the students' view
- with the words "watch me turn the water into wine," pour the base into the indicator, in front of the students
- use a yes/no question format to help students arrive at the explanation

Exploration

Students do Activity 8.5: Identifying Properties of Acids and Bases.

Development

Based on previous learning and Activity 8.6, use a class discussion to help students develop an understanding that:
- acids and bases have characteristic properties that can be tested and used for identification
- there are specific rules for naming and writing formulas for acids and bases

Application

Practise naming, writing formulas for common acids and bases.

Follow up on Activity 8.5 by providing students with unidentified samples of acids and bases or neutral solutions, to classify.

Significance

Have students investigate why "Drano" can unclog a drain.

Have students test foods for Vitamin C content using a 0.10% starch solution to which a drop of tincture of iodine has been added. This blue solution will decolourize in the presence of ascorbic acid.

Have students design an investigation into the effect of simulated acid rain (1.0 mol/l sulphuric acid) on various materials, including living tissue.

Ask students to prepare a poster or brochure outlining how to handle, store and dispose of acids and bases safely.

Evaluation

1. Quizzes and Exercises
   - name and provide formulas for common acids and bases
   - provide the properties of acids and bases and the laboratory tests for identifying them

2. Activities
   For Activity 8.5; mark only the experimental design, the evaluation, and suggestions for improvement.

   Give marks for correctly classifying unknown solutions.

3. Investigations

   Mark student report of the investigation into Vitamin C content and/or the effect of acid rain on materials.

Exemplar 4 Ionic and Molecular Compounds

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **themes** emphasized are *matter, change* and *energy.*

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *formulating questions, hypotheses, and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise, effective form*

Analyzing

- *identifying and discussing sources of error and their effect on results*

Connecting, Synthesizing and Integrating

- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*
- *suggesting alternatives and considering improvements to experimental technique and design*

*The **STS connections** emphasized are:*

- *the functioning of products or processes based on scientific principles*
- *the limitations of scientific knowledge and technology*
- *the inability of science to provide complete answers to all questions*
- *the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *differentiating, on the basis of properties, among ionic and molecular compounds*
- *identifying the role of ionic and molecular compounds in living systems*
- *naming and writing formulas for selected ionic and molecular compounds*

Skills

- *investigating the properties of representative ionic and molecular compounds in laboratory experiments and in resources such as a chemistry textbook*

STS Connections

- *researching the synthesis and uses of ionic and molecular compounds*
- *listing some compounds essential to human health*
- *listing some compounds hazardous to human health and the environment*

Introduction

Students investigate the labels of household products for listings of compounds, trying to guess (from the names) the elements contained in them.

Students cut out newspaper articles that refer to chemical compounds and, similarly, analyze the names.

Exploration

Perform Demonstration 8.1: Electrolysis of Compounds to Produce Elements.

Perform Activity 8.4: Deriving Rules for Naming Compounds.

Development

Through a class discussion help students come to the understanding that:
- compounds are composed of elements
- there are two kinds of compounds – ionic and molecular – with distinctive properties
- there are rules for naming compounds and writing their formulas

Application

Students do Activity 8.3 *(Visions 1)*: Investigating Ionic and Molecular Compounds.

Have students do exercises in naming common compounds.

Make ties to Units 1 and 2 by revisiting some of the compounds mentioned there and classifying them as ionic or molecular.

Tie this to the acid and base lesson, pointing out the specific properties that apply only to acids and bases which are also compounds.

Follow-up on Activity 8.3 by providing students with unidentified compounds to classify as ionic or molecular.

Significance

Investigate a significant compound (everyday, industrial or environmental importance).

Have a class discussion on the importance of a global communications system for the names and formulas of the compounds.

Prepare toothpaste or some other common household product and test it for efficacy. (Refer to *The Formula Book* by Norman Stark, Avon Books (1977) or *Science in the Marketplace* by Florence Korchin, Tiger Publications (1987) for recipes.)

Evaluation

1. Quizzes and Exercises
   - name and provide formulas for common ionic and molecular compounds
   - describe the characteristics and tests for the properties of ionic and molecular compounds

2. Activities
   - provide marks for bringing in labels, newspaper clippings
   - have students submit a report of Activity 8.3
   - provide marks for correctly classifying unidentified substances as ionic and molecular compounds

3. Investigations
   - require a written or oral report on a significant compound or describing students' test of a homemade household product

Course of Studies

Applicable Resources inserted into the course of studies to facilitate planning • Print * AV

UNIT 4
ENERGY AND CHANGE

OVERVIEW

Science Themes: *Energy, Matter* and *Change*

In Unit 4, students quantitatively investigate *energy* changes and develop their understanding of *energy* transformation and conservation. The unit concludes with a project in which students design and build a simple *energy* conversion device and evaluate its efficiency.

This unit builds on Science 7, Unit 3: Force and Motion, and Unit 4: Temperature and Heat Measurement; Science 9, Unit 3: Heat Energy: Transfer and Conservation, and extends the concepts of *energy* transformation introduced in Unit 1, and treated in their biological and chemical contexts in Units 2 and 3. The attitudes, knowledge and skills developed in this unit provide students with a foundation for the study of energy and conservation topics in Science 20 and Physics 20.

The four **major concepts** developed in this unit are:

- *energy* is always associated with *change*
- *energy* can be transformed from one form to another
- *energy* cannot be created or destroyed, only converted from one form into another
- the useful *energy* diminishes during any *energy* transformation.

In this unit, students will develop an ability to use the **skills and thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from their investigations of *energy* change.

The **STS connections** in this unit illustrate:

- the functioning of products or processes based on scientific principles
- the use of technology to solve practical problems
- the ability and the responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations.

ATTITUDES

Students will be encouraged to:

- develop a positive attitude toward mathematical, communication and scientific processes and skills in the study of energy
- appreciate the need for computational competence in quantifying energy and energy transfers
- respect evidence when interpreting observed phenomena related to energy
- appreciate that science is a disciplined way to develop explanations and descriptions about energy in the natural and technological world
- accept uncertainty in our descriptions and explanations of observations related to energy in the physical world.

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. Energy is always associated with change.	• energy is always associated with change, by extending from Science 8, Unit 2, the definition of mechanical work, and quantifying the work done on/by an object, using $W = Fd$; by extending from Science 7, Unit 3, the notions of force, mass and weight; and by:
	• illustrating, by use of examples, that energy exists in a variety of forms; e.g., mechanical, chemical, electrical, thermal, nuclear and solar
	• illustrating, by use of examples, that the Sun is the source of most energy forms on Earth
	• describing one-dimensional uniform motion, using graphical and mathematical techniques
	• defining energy as the property of a system that is a measure of its capacity for doing work, and work is the transfer of energy
	• deriving the unit of energy and work, the joule, from fundamental units

•Alberta Wildflowers: Teacher Resource Kit
*Energy (Science Show Series)
*Energy and Heat Loss (Science in Focus Series)
*Energy in Canada's Remote Communities
*Global Warming: Hot Times Ahead
*Interactive Physics
*Living Textbook – Physical Science
*Our Environment
*Physics and Automobile Collisions
*Physics of Sports
•SEEDS (Energy Literacy Series)
•Somebody Should Do Something About This

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• making a synopsis of energy as it has been discussed in earlier units	• discussing the importance of the Sun as an energy source for life on Earth
• tracing the flow of energy from the Sun to the lighting system in the school, identifying what changes are taking place at each stage of the process	• describing the technologies involved in current sources of energy
• performing an experiment to determine the relationships among distance, speed and time	• analyzing the energy transfers occurring as an automobile or a bicycle comes to a stop
• investigating the relationships among distance, speed and time, using interval timers	• analyzing the movement of passengers in an automobile changing direction
• interpreting the slope of a curve in a distance–time graph in terms of speed	
• interpreting the area under a speed–time graph as the distance travelled	
• interpreting the area under a force–distance graph as the work done	

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
2. Energy can be transformed from one form to another.	• energy can be transformed from one form to another, by extending from Science 7, Unit 4, that thermal energy can be derived from a variety of sources, and by:
	• defining kinetic energy as energy due to motion, and potential energy as energy due to position or condition
	• potential energy is only useful when it is transformed to another form of energy
	• illustrating, by use of examples, that energy transfers produce measurable changes in motion, shape or temperature of matter
	• defining gravitational potential energy as the work done on a mass against gravity, and quantifying gravitational potential energy, using $E_p = mgh$
	• quantifying kinetic energy, using $E_k = 1/2mv^2$
	• recognizing chemical energy as a form of potential energy, and describing the potential energy stored in a battery
	• quantifying electrical energy, using $E_e = Pt$
	• explaining the effect of thermal energy on matter, using the kinetic molecular theory as a simple mechanical model
	• describing temperature changes in terms of changes in the kinetic energy of the molecules of a substance
	• describing phase changes in terms of the kinetic molecular theory
	• analyzing units to describe the kilowatt hour as a unit of energy, and the watt as a unit of rate of energy transfer or a unit of doing work

- •Alberta Wildflowers: Teacher Resource Kit
- •Coal to Kilowatts
- *Energy (Science Show Series)
- *Energy From The Sun
- *Energy Transfer (Science in Focus Series)
- *Global Warming: Hot Times Ahead
- *Interactive Physics
- *Light and Energy
- *Living Textbook – Physical Science
- *Our Environment
- *Physics of Sports
- •Potential Energy (Mechanical Universe Series)
- •Potential Energy and Kinetic Energy
- •SEEDS (Energy Literacy Series)
- •Shocking Truth
- •Somebody Should Do Something About This
- *States of Matter (World of Chemistry)

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• investigating energy conversions, using laboratory equipment • calculating the energy consumption of selected household technologies; e.g., toaster, microwave oven or refrigerator • discussing an experiment to demonstrate the conversion of chemical potential energy to thermal energy, involving a combustion reaction • performing an experiment to demonstrate the conversion of energy from a potential form to a kinetic form, using a pendulum • performing an experiment to demonstrate the equivalency of work done on an object, and the resulting kinetic energy	• describing current technologies for converting energy from one form to another; e.g., hydroelectric and coal-burning power stations, solar cells • describing technological devices that use chemical potential energy as an energy source

MAJOR CONCEPTS	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. Energy cannot be created or destroyed, only converted from one form into another.	• conservation of energy is a fundamental law of nature, by: • stating the Law of Conservation of Energy as "the sum of initial energies is equal to the sum of final energies" • recognizing the First Law of Thermodynamics as a statement of the Law of Conservation of Energy • describing, by use of examples, that thermal energy will, of its own accord, flow from a hotter body to a cooler body, and recognizing this as a formal statement of the Second Law of Thermodynamics • comparing and contrasting the mechanism of osmosis and thermal energy transfer according to the Second Law of Thermodynamics
4. The useful energy diminishes during any energy transformation.	• the amount of useful energy diminishes during any energy transformation, by: • interpreting empirical data from a study of energy conversions • explaining that energy conversion processes have different efficiencies, based on total energy input compared to the net useful energy output • defining inefficiency as the fraction of energy lost as wasted heat in the conversion process • describing techniques for reducing waste of energy.

•Alberta Wildflowers: Teacher Resource Kit
*Back to the Sun
•Coal to Kilowatts
*Concept of Energy Flow (Energy Flow Series)
*Conservation of Energy (Mechanical Universe Series)
*Energy (Science Show Series)
*Energy and Heat Loss (Science in Focus Series)
*Energy in Canada's Remote Communities
*Energy Transfer (Science in Focus Series)
*Global Warming: Hot Times Ahead
•Keephills: Moving for Progress
*Living Textbook – Physical Science
•Mining
*Our Environment
*Potential Energy and Kinetic Energy
•Reclamation
•SEEDS (Energy Literacy Series)
•Some Facts
•Somebody Should Do Something About This
•Sundance Generating Plant
•Wabamun Generating Plant
•Water Power

•Alberta Wildflowers: Teacher Resource Kit
•Coal to Kilowatts
•Current Living Series
•Keephills: Moving for Progress
*Light and Energy
*Living Textbook – Physical Science
•Mining
•More Power to You
*Our Environment
•Reclamation
•SEEDS (Energy Literacy Series)
•Some Facts
•Somebody Should Do Something About This
•Sundance Generating Plant
•Wabamun Generating Plant

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science by:	*Students should be able to demonstrate an understanding of the processes by which scientific knowledge is developed and of the interrelationship of science, technology and society by, among other activities:*
• tracing the stages of energy conversion in a system; e.g., a power plant or food chain, and identifying the sources of energy loss • designing an experiment to investigate the conservation of energy in a closed system • performing an experiment to demonstrate the similarities between osmosis and thermal energy transfer	• describing the energy transfers, and how they are achieved, in various conversion systems; e.g., refrigerator, heat pump, thermal power plant • commenting on the feasibility of perpetual motion machines • comparing and contrasting the energy transfers and technologies in a hydroelectric plant and a thermal power plant • discussing the role of alternative energy sources to generate energy in Alberta
• conducting an investigation in which the efficiency of common technological devices used to heat a specific amount of water is quantified and evaluated • performing an experiment in which mechanical energy is converted into heat energy • performing an experiment in which electrical energy is converted into heat energy • designing and building an energy conversion device and calculating its efficiency.	• comparing and contrasting the energy content of fuels used in thermal power plants in Alberta • discussing the use of fossil fuels in thermal power plants in Alberta • discussing the role of efficiency of energy conversion to encourage responsible energy use • discussing the impact of displaying energy consumption labels on household appliances.

Exemplar 1 Investigating Different Methods of Generating Electricity (in Alberta)

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **theme** emphasized is *energy*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *differentiating between relevant and irrelevant data or information*
- *formulating questions, hypotheses and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure if necessary*
- *accurately observing, gathering and recording data or information according to safety regulations (e.g,. WHMIS) and environmental considerations*

Organizing and Communicating

- *organizing and presenting data (themes, groups, tables, graphs, flowcharts and Venn diagrams) in a concise and effective form*
- *communicating data more effectively using mathematical and statistical calculations where necessary*
- *communicating findings of investigations in a clearly written report*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying assumptions, attributes, biases, claims or reasons*
- *identifying main ideas*

Connecting, Synthesizing and Integrating

- *predicting from data or information*
- *identifying further problems or issues to be investigated*
- *identifying alternatives for consideration*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *answering the problem investigated*
- *summarizing and communicating findings*

- *deciding on a course of action*

Evaluating the Process or Outcomes

- *establishing criteria to judge data or information*
- *considering consequences and perspectives*
- *identifying limitations of the data, or information and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*

*The **STS connections** emphasized are:*

- *the inability of science to provide complete answers to all questions*
- *the functioning of products or processes based on scientific principles*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the limitations of scientific knowledge and technology*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the ability and responsibility of society, through science and technology, to protect the environment, and use natural resources judiciously to ensure quality of life for future generations*

Specific Learner Expectations

Knowledge

- *illustrating, by use of examples, that energy exists in a variety of forms; e.g., mechanical, chemical, electrical, thermal, nuclear and solar*
- *illustrating, by use of examples, that the Sun is the source of most energy forms on Earth*
- *defining kinetic energy as energy due to motion, and potential energy as energy due to position or condition*
- *potential energy is only useful when it is transformed to another form of energy*
- *illustrating, by use of examples, that energy transfers produce measurable changes in motion, shape or temperature of matter*
- *analyzing units to describe the kilowatt-hour as a unit of energy, and the watt as a unit of rate of energy transfer or a unit of doing work*
- *stating the Law of Conservation of Energy as "the sum of initial energies is equal to the sum of final energies"*
- *describing, by use of examples, that thermal energy will, of its own accord, flow from a hotter body to a cooler body, and recognizing this as a formal statement of the Second Law of Thermodynamics*
- *explaining that energy conversion processes have different efficiencies, based on total energy input compared to the net useful energy output*
- *defining inefficiency as the fraction of energy lost as wasted heat in the conversion process*

Skills

- *tracing the flow of energy from the Sun to the lighting system in the school, identifying what changes are taking place at each stage of the process*
- *tracing the stages of energy conversion in a system; e.g., a power plant or food chain, and identifying the sources of energy loss.*

STS Connections

- *discussing the importance of the Sun as an energy source for life on Earth*

- *describing the technologies involved in current sources of energy*
- *describing current technologies for converting energy from one form to another; e.g., hydroelectric and coal-burning power stations, solar cells*
- *describing the energy transfers and how they are achieved in various conversion systems; e.g., refrigerator, heat pump, thermal power plant*
- *comparing and contrasting the energy transfers and technologies in a hydroelectric and a thermal power plant*
- *discussing the role of alternative energy sources to generate energy in Alberta*
- *comparing and contrasting the energy content of fuels used in thermal power plants in Alberta*
- *discussing the use of fossil fuels in thermal power plants in Alberta*
- *discussing the role of efficiency of energy conversion to encourage responsible energy use*
- *evaluating and assessing ideas, information and alternatives.*

Comments: The focus of this exemplar is on an STS research project. Students work in cooperative learning groups to investigate the use of various energy sources for the generation of electricity in Alberta. Each energy source is examined from specified STS perspectives (see page 14 of this exemplar).

The project is carried out over the whole unit to provide enough time for the students to plan their methods of investigation, collect, organize and analyze information, and finally produce a group report and a group presentation.

It is possible to complete this research project in a shorter time period. For example; one topic can be explored by the whole class; groups of students can research different aspects of this topic and share their results at the end.

Timing

Approximately three 60-minute classes are required for:

(a) introduction, exploration and development of the topic
(b) organization and initiation of research
(c) group presentations at end.

In addition, 5 to 30 minutes of class time should be allocated periodically to enable group members to check on one another's progress and plan their final reports and presentations—and to give the teacher a chance to check students' work.

Introduction

Divide the class into six cooperative learning groups (four or five students per group).

Have each group select:

- a leader
- a spokesperson
- a recorder
- a timekeeper—to make sure the group completes work on time
- one or two critics—to act as devil's advocate(s)

For more information on Cooperative Learning strategies, refer to pages ??? in this manual.

Place the following headline on the overhead (or blackboard)

"NUCLEAR POWER PLANT PROPOSED FOR (NAME OF CITY, TOWN OR COMMUNITY")

Suggestion: provide a location in the neighbourhood of the school.

Have the groups discuss the hypothetical situation and write a summary of the ideas presented.

The following may be used as a guide.

1. List the advantages of constructing a nuclear power plant in your community. Be specific; for example, will jobs be created? Will the cost of energy be cheaper?

2. List the disadvantages of constructing a nuclear power plant in your community.

3. Summarize what you would expect the opinion of the general public to be concerning this issue. What about specific groups of people, such as environmentalists?

4. Decide what scientific knowledge should be provided to members of the public for them to formulate an opinion based on some facts.

A brief sharing of ideas, among the whole class, should be presented by a group representative.

Have the spokesperson for each group present the ideas of his/her group during a brief idea-sharing session.

Provide no explanations at this time. Collect the group summaries at the end of the unit, after all of the groups have presented their research findings, return the group summaries. Repeat the Introduction Activity, having the students compare their original ideas with the ideas they have after researching the different energy sources.

Exploration

Students continue to work in their cooperative-learning groups.

Teacher Activities	Student Activities
• Ask student groups to list all of the possible energy sources for generating electricity in Alberta. Give each group an overhead transparency or sheet of large chart paper and the appropriate marker.	• Students list these: i.e., coal natural gas falling water solar energy wind energy nuclear energy
• Have groups compare lists.	• Groups compare lists
• Ask student groups to list all of the factors which might influence the decision to choose a specific energy source for the generation of electricity—on same transparency or sheet of chart paper.	• Students list these factors. They may include: 1. Natural resources—available (coal, natural gas, etc.) 2. Natural topography—features that would accommodate a hydroelectric dam. 3. Weather—number of cloudy days for solar power or number of windy days for wind generators. 4. Environmental and land development concerns—pollutants released from the plant, location of the plant. 5. Economic resources—jobs created during construction of the plant, cost of the plant versus other sources.
• Have groups compare lists and discuss the various factors.	• Groups compare lists—discuss the factors.

Development

Teacher directs class discussion to help students develop the following concepts. (Note: several of these can be developed in other Unit 4 lessons, as well.)

- energy exists in a variety of forms
- the Sun is the source of most energy forms on Earth (for example the flow of energy from the Sun to the lighting system of the school can be traced)
- kinetic energy is energy due to motion and potential energy is energy due to position or condition
- potential energy is only useful when it is transformed to another form of energy
- energy cannot be created or destroyed, only converted from one form into another
- the useful energy diminishes during any energy transformation i.e., energy conversion processes have different efficiencies, based on total energy input compared to the net useful energy output

- the possible energy sources for the generation of electricity in Alberta are
  - coal – thermal electricity
  - natural gas
  - falling water – hydroelectricity
  - solar energy
  - wind energy
  - nuclear energy
- each energy source requires different technology
- various factors influence the decision to choose a specific energy source
- an informed decision can be made by considering each energy source from different perspectives, i.e.,
  - ecological
  - economic
  - legal
  - political
  - scientific
  - technological

A more detailed description of these STS perspectives follows:

STS Perspectives

1. Ecological Perspective—involves the examination of the effects of any factor on the environment.

2. Economic Perspective—involves costs related to the energy source. Costs related to research and development, the technology itself, the consumer and the workers may be included.

3. Legal Perspective—involves the law. Are there legal matters associated with the issue? Does the new energy source involve the purchase of land or the relocation of residents?

4. Political Perspective—involves government policy on an issue. What levels of government might be involved? In what capacity? Are there political risks involved?

5. Scientific Perspective—what is known about this type of energy source? What research is still needed? What data, observations and conclusions support or not support the implementation of this energy source?

6. Technological Perspective—involves present or future research and development of the technology required for the energy source. Does the technology provide a solution for the energy needs of the community?

Application

Assign the research project.
Set specific dates for the completion of different stages and the final product and presentations.
For more information on library research in science refer to the *Senior High Science Teacher Resource Manual*, S.3G, and Section 5 in this manual, or to *Focus on Research* (Alberta Education) 1990.

Use the following as a guideline for the assignment

- each group investigates a different energy source
- all group members research the scientific perspective and one (or two) other perspective(s) so that each energy source is being studied from all perspectives

- a variety of resources is to be used for gathering information, for example,
  - reference books
  - videos/films
  - community sources

- each group compiles the work of its members to produce a group report
- group reports may be supplemented with taped interviews with community members, photographs, charts, graphs, videos, a scrapbook or correspondence from individuals affecting or affected by the energy source
- each group presents its results to the rest of the class
- group presentations may include a variety of forms—lecture, dramatization, slides or video—or audiotape, etc.

If possible arrange with the school librarian to have students begin their search for information immediately with his/her assistance.

Suggested Resources

Visions 1—Science 10 textbook, chapters 11 and 12.

Somebody Should Do Something About This—a teacher's resource book on energy and the environment. This excellent resource binder was sent to all school libraries in April 1992. Contact Alberta Energy, Energy Efficiency Branch (403) 427-5200, if your school did not receive one.

Alberta Education documents:

- Alberta Education. 1990. *STS Science Education: Unifying the Goals of Science Education.* Curriculum Support Branch, pages 30–43.

- Alberta Education. 1990. *Focus on Research: A Guide to Developing Students' Research Skills.* Curriculum Support Branch.

National Film Board of Canada

- *Tomorrow's Energy Today.* 16 mm film 31 min. 49 sec. 1981.
  Alternate energy sources combined with fossil fuels.

- *A World of Energy 1.* Video, 1987. Topic Part 1: How atomic reactors produce electricity. Candu reactor is examined. 12 min. 23 sec.
  Part 2: Shows how people are using sun, wind and wood to meet energy needs. 24 min. 49 sec.

- *A World of Energy 2* Video 1987
  Part 1: Wind energy. 11 min. 48 sec.
  Part 2: Solar energy. 10 min. 43 sec.

University of Alberta Educational Media Services, Faculty of Extension

- *Fusion Work in Progress* Video 1989 25 min.

Other Sources

- Statistics Canada 1991. *Canada Yearbook*
  Available from Publications Sales and Services, Statistics Canada, Ottawa, Ontario, K1A 0T6

- *Corpus Almanac and Canadian Sourcebook.* 1991. Southam Business Information and Communications Group Inc.

- *Canadian World Almanac and Book of Facts.* 1991.
  Available from Global Press, 164 Commander Blvd., Agincourt, Ontario, M1S 3C7

- *Keephills: Moving for Progress.* TransAlta Utilities. (See Resources, S.5.)

- *How to Use the Readers' Guide,* the Wilson Video Resource Collection
  Available from Wilson Video Resource Collections, 950 University Ave., Bronx, New York, NY, 10452, USA. 1-212-588-8400

- Social Issues Resources Series Inc. (SIRS INDEX)
  Available from P.O. Box 2348 Boca Raton, Florida, USA 33427-2348, 1-800-327-0513
  Compilations from hundreds of magazines concerning social issues related to all subject areas. Possible to receive updates.

Significance

Connections with Nature of Science

The nature of science can both create and solve social issues.

- For example, science knowledge was originally used to produce nuclear, generating stations and thermal power stations. The resulting social issues were the problems of nuclear waste disposal and the problem of pollution created by the burning of coal or natural gas. Subsequently, coal low in sulphur and other pollutants was burned and scientifically based systems of nuclear waste disposal management were developed.

- Have groups or individual students use the periodical index to find other energy generation situations where science produced an issue or where it solved an issue.

- The Alberta Oil Sands Project may provide some information. Students may compile the information in a scrapbook or create a bulletin board display.

- Students interested in history may also choose an alternate assignment involving the history of the development of the scientific principles associated with various forms of energy transformation. Examples may include the history behind solar power, windmills, turbines, etc.

- The scientific research and its relationship to the society at the time may provide clues to social issues that had to be solved. Students should be encouraged to watch for situations where scientific research was discouraged because of societal reasons.

Connections with Technology

Technology and social issues are also closely linked. Often it is the technology that creates a social issue or solves it.

- The technology behind the Candu reactor was used by Canada to help Third World countries. India was helped in such a manner. As a result, the electrical energy needs of a country with a huge population were beginning to be met. This is an example of technology helping a social problem. However, this technology can create a social issue if the fission by-products are used to create a nuclear bomb.

- When it was decided to build the hydroelectric project, the Big Horn Dam near Rocky Mountain

House, a great controversy erupted. Ancient Native burial grounds were flooded. Eventually, an agreement was reached between the government and the Natives living in the area.

- These two examples, that were of international and national importance, can provide an opportunity for a case study or research topic in themselves. Have students research back issues of newspapers and magazines for more information and post results on a bulletin board labelled "Social Issues and Science".

- Hypothetical situations can also be presented to the students and provide an opportunity for an interactive debate. What kind of reaction would you have if a thermal power plant using fossil fuels was to be built near your cattle farm? Contrast and compare the pros and cons.

- Study the Keephills Generating Plant Project. Here is an Alberta project that involved moving the whole hamlet of Keephills. A perfect opportunity to see science and social issues in action.

Evaluation

1. The following can be used to evaluate group reports and presentations:

	1	2	3
A. Organization and Planning • introduction • orderly development from idea to idea • sense of conclusion.			
B. Accuracy and Relevance of Science Presented • demonstrates a knowledge and practical understanding of the science involved • science involved is relevant to the topic • science involved is accurate.			
C. Presentation of Perspectives			
1. Ecological Perspective • main idea or focus • adequate support for main idea with appropriate details.			
2. Economic Perspective • main idea or focus • adequate support for main idea with appropriate details.			
3. Legal Perspective • main idea or focus • adequate support for main idea with appropriate details.			

Evaluation (Continued)

	1	2	3
4. Political Perspective • main idea or focus • adequate support for main idea with appropriate details. 5. Scientific Perspective • main idea or focus • adequate support for main idea with appropriate details. 6. Technological Perspective • main idea or focus • adequate support for main idea with appropriate details. D. Communication (Written and Oral) • quality of expression, grammar and word use E. Visuals • support for ideas presented F. Bibliography • complete references			

2. Repeat the introduction activity to check if students have "learned" anything (i.e., has there been any noticeable change in student thinking?)

3. Hold a mock plebiscite. Have students make a decision based on the information gained from research and group presentations.

Have students reflect on individual and group performance. The following scales may be used.

Self-rating Scale for Group Activity

Name: _____ Activity: _____

Date: _____

	Not at All	Somewhat	Extremely
1. How clear were you about your role in this group?	☐	☐	☐
2. How well were you able to focus your attention on the task?	☐	☐	☐

Self-rating Scale for Group Activity (Continued)

	Not at All	Somewhat	Extremely
3. How completely did you share your ideas?	☐	☐	☐
4. How much effort did you put into trying to influence decisions?	☐	☐	☐
5. How effective were you in influencing decisions?	☐	☐	☐
6. How well did you listen to others?	☐	☐	☐
7. How sensitive and supportive were you to others' feelings and ideas?	☐	☐	☐
8. Overall, how satisfied were you with your contribution to this activity?	☐	☐	☐

Look back over your ratings on this sheet and place check marks beside two areas in which you could improve. In the space below, set targets or reminders which could help you to improve.

Group Self-rating Scale for Group Activity

Place an X on each scale to indicate how this group would be rated for the task just completed.

Clear task and sequence activities	—	—	—	—	Confused. No idea what to do.
Extremely trusting and open with each other.	—	—	—	—	No trust. A closed group.
Extremely sensitive and supportive to each other.	—	—	—	—	No awareness or concern for others.
All members took part effectively.	—	—	—	—	Only one or two contributed.
Disagreements welcomed and explored	—	—	—	—	Disagreements avoided or repressed.
Decisions made by consensus.	—	—	—	—	No decisions reached at all.
Leadership strong, flexible and shared.	—	—	—	—	No leadership—drifted.

Exemplar 2 Defining Gravitational Potential Energy as the Work

Classroom implementation of this exemplar would address the following **General** and **Specific Learner Expectations** from the Science 10 Course of Studies.

General Learner Expectations

The **theme** emphasized is *energy*.

The aspects of the **skills framework** emphasized are:

Initiating and Planning

- *identifying and clearly stating the problem or issue to be investigated*
- *differentiating between relevant and irrelevant data or information*
- *identifying all variables and controls*
- *identifying materials and apparatus required*
- *formulating questions, hypotheses and/or predictions to guide research*
- *designing and/or describing a plan for research or to solve the problem*
- *preparing required observation charts or diagrams*

Collecting and Recording

- *carrying out and modifying the procedure, if necessary*
- *organizing and correctly using apparatus and materials to collect reliable experimental data*
- *accurately observing, gathering and recording data or information according to safety regulations and environmental considerations*

Organizing and Communicating

- *organizing and presenting data in a concise and effective form*
- *communicating data more effectively, using mathematical and statistical calculations where necessary*
- *expressing measured and calculated quantities to the appropriate number of significant digits, and using appropriate SI units for all quantities*
- *communicating findings of investigations in a clearly written report*

Analyzing

- *analyzing data or information for trends, patterns, relationships, reliability and accuracy*
- *identifying and discussing sources of error and their effect on results*
- *identifying main ideas*
- *identifying assumptions, attributes, biases, claims or reasons*

Connecting, Synthesizing and Integrating

- *formulating further testable hypotheses supported by the knowledge and understanding generated*
- *developing theoretical explanations*
- *relating the data or information to laws, principles, models or theories identified in background information*
- *answering the problem investigated*
- *summarizing and communicating findings*

Evaluating the Process or Outcomes

- *establishing criteria to judge data or information*
- *suggesting alternatives and considering improvements to experimental technique and design*
- *identifying limitations of th data or information, and interpretations or conclusions, as a result of the experimental/research/project/design processes or methods used*

*The **STS connections** emphasized are:*

- *the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted*
- *the functioning of products or processes based on scientific principles*
- *the ways in which science advances technology and technology advances science*
- *the use of technology to solve practical problems*
- *the influence of the needs, interests and financial support of society on scientific and technological research*
- *the use of technology to solve practical problems*

Specific Learner Expectations

Knowledge

- *defining energy as the property of a system that is a measure of its capacity for doing work, and work as the transfer of energy*
- *deriving the unit of energy and work, the joule, from fundamental units*
- *defining kinetic energy as energy due to motion, and potential energy as energy due to position or condition*
- *potential energy is only useful when it is transformed to another form of energy*
- *illustrating by use of examples that energy transfers produce measurable changes in motion, shape or temperature of matter*
- *defining gravitational potential energy as the work done on a mass against gravity, and quantifying gravitational potential energy, using $E_p = Mgh$*
- *stating the Law of Conservation of Energy as "the sum of initial energies is equal to the sum of final energies"*

Skills

- *using laboratory equipment to investigate energy conversions*
- *performing an experiment to demonstrate the equivalency of work done on an object and the resulting kinetic energy*

STS Connections

- *describing current technologies for converting energy from one form to another*

Comments: The initial focus of this lesson is on the nature of science. Students are asked to use their knowledge of work, potential energy and kinetic energy, and the Law of Conservation of Energy to design, write and carry out a procedure to demonstrate that the work done on an object against gravity is equal to the increase in its gravitational potential energy.

Time

Approximately two 60-minute classes are required. The total time depends on how long the students are allowed to design and carry out their short experiment.

Recommendation:

60 minutes for brainstorming group questions (four questions), experimental design, begin experiment.
60 minutes to complete experiment, write up experiment, critique another group's experimental design and respond to critique.

Prior Knowledge

Students should have already begun study of Unit 4 and should be able to:

- define energy, work, potential energy and kinetic energy
- state the Law of Conservation of Energy
- derive the unit of energy and work, the joule
- quantify the work done on or by an object, i.e., $W = Fxd$

Suggested Resources

ACCESS Television Network

- *The Mechanical Universe: Potential Energy*, ACCESS TV
  # VC 291414 Video, 1985. 28 min. 38 sec.

- *Principles of Technology: Unit 5 Energy*, ACCESS TV
  # VC 263305 Video
  First Part: Work, Gravitational Potential Energy, Kinetic Energy, Potential Energy. 8 min. 38 sec.

Alberta Education

- Alberta Education. 1990. *STS Science Education: Unifying the Goals of Science Education*,Curriculum Support Branch, pages 10–18.

Books

- *Visions 1* – Science 10 textbook Chapters 10 and 11.

- Brancazio, Peter J. 1984. *Sport Science Physical Laws and Optimum Performance*, New York, Simon and Schuster Inc.

- Flatow, Ira. 1989. *Rainbows, Curve Balls and Other Wonders of the Natural World Explained*, New York: Harper & Row.

- Hawkey, Roy. 1984. *Sport Science*, Toronto: Hodder and Stoughton.

- Schreier, E.W. and W.F. Allman, ed. 1984. *Newton at the Bat: The Science in Sports*, New York: Charles Scribner's Sons.

Introduction

Announce that you will be performing two important demonstrations that will test the students' powers of observation and thinking. Provide no further explanation, but do encourage student

discussion. To avoid confusion, use two different colours of plasticine, one colour for Demo 1 and another colour for Demo 2.

Demo 1 Take three plasticine balls of different mass and place them on a centrally located table. Lift each ball approximately 1 m above the table and then drop it.

Demo 2 Take three plasticine balls of same mass and place them on the table. Lift each ball to a different height (0.5 m, 1 m, 1.5 m) and then drop it.

Allow students to examine the balls visually.

Exploration

Organize students into small brainstorming groups (3 or 4 students per group). Write the following questions on the blackboard:

1. After they are dropped, how do the balls differ in a) Demo 1; b) Demo 2?
2. What factors affect the differences found in the balls in a) Demo 1; b) Demo 2?
3. How do these factors involve work, potential and kinetic energy?
4. What parts of the demos exhibit work, potential and kinetic energy?

Have each group select a group recorder and a group reporter (spokesperson). Allow the groups 10–15 minutes to discuss their answers and, once consensus is achieved, the recorders write their responses. Remind students that their textbook does contain information on this topic, but do not give them page or section numbers.

> Although students may not be aware of it, they are involved in an activity that models the manner in which science is conducted, i.e., observation, inference and explanation.

Development

Lead class discussion to:

- review definitions of work, energy, potential energy, kinetic energy, and the Law of Conservation of Energy
- develop correct answers to the questions asked in the exploration stage
- develop the concept that gravitational potential energy is equal to the work done on a mass against gravity
- determine mathematically (quantify) gravitational P.E. using $E_p = mgh$
- determine mathematically the relationship between work done against gravity and gravitational potential energy.

You may wish to show the link between work and gravitational potential energy by beginning with a unit analysis.

i.e.,	Quantity	Unit
	Energy	$J = (N \cdot m)$
	Force	$N = (kg \cdot m/s^2)$
	Work	$Fd = (kg \cdot m/s^2)$

Students should then come to recognize that work (W) done against gravity equals gravitational energy (E_p).

$W = E_p$
$Fd = mgh$

Application

1. Challenge each brainstorming group to design, write and carry out an experiment, using known masses, force scales and a metre stick, to show that the work done on an object against gravity is equal to the increase in its potential energy.

   (Demonstrate how to use a force scale if necessary.)

2. Have each group give you two copies of their procedure before they begin to do it – the duplicate will be given to another group to critique.

   Since this is the last unit of the course, students should already be familiar with the stages of the inquiry process. Give as much or as little specific guidance as required. Remind them that several trials will increase the reliability of their results.

3. Cut off names and place a code number on each duplicate procedure. Return originals to groups.

4. Have the groups carry out their procedures, record results, etc. Each group will hand in one completed group report.

   Example: Students might take a 1.00 kg mass and lift it to a height of 2.00 m above the floor.

   $E_p = mgh \quad = 1.00\ kg \times 9.81\ m/sec \times 2.00\ m$
   $= 19.6\ (kg \cdot m/s^2)m$
   $= 19.6\ J$
   And $W = Fxd$ – using force scale to measure force
   $W = 9.81N \times 2.00\ m$
   $= 19.6\ Nm$
   $= 19.6\ J$

5. Have the groups evaluate their own procedures and results; identify sources of error, suggest improvements to experimental design and procedure, etc.

6. Collect group reports for teacher evaluation.

7. Hand out the coded duplicate procedures and have the groups critique one another's experimental designs. Critiques must be in writing.

8. Collect the critiques and coded duplicates and return them to the original groups for rebuttal during a class information-sharing session.

Significance

Connections with Technology

The science knowledge presented in this lesson can easily be related to various technological applications.

- For example, a discussion involving the work that a ski lift must do can be initiated. Companies that make ski lifts are always searching for equipment that is energy efficient. Engineers are continually designing new equipment that will make the lift work efficiently while quickly lifting the skiers from the base to the top of the mountain or hill. Students can often share their own experiences with ski lifts in terms of speed, length, capability etc.

- The ideas involved with E_p and work can also be applied to other sports. There is an incredible amount of physics behind all sports and this gives students the opportunity to apply science knowledge to something they can identify with. Science knowledge can be applied to everything from pole vaulting to gymnastics to the design of footwear for specific sports.

- Have students watch for advertisements in magazines and on television that use physics ideas as a marketing technique. Students may want to write to athletic footwear manufacturers for more information. In the past, posters and information relating physics to sports have been available from the distributors of scientific equipment and materials. Magazines such as *Physics Teacher* are also a good source for posters and related information.

Connections to Science-Related Social Issues

Science knowledge can also be related to social issues.

- The knowledge of work and energy can be applied to the production of footwear and sports equipment so that athletes become more efficient in their energy use. Does this take away from the actual ability of the athlete? Do some athletes have advantages over others who may not have the best equipment? Have students ask their coaches if they use any physics ideas to enhance a player's ability. Students should be able to identify science-based ideas that are being used.

- Better footwear and equipment can lead to fewer sports injuries. What are the implications for society?

- The influence of the needs, interests and financial support of society on the scientific and technological research of sports activities and equipment can be discussed.

Other Examples, Applications and Models

- The concept that E_p is equal to the work done against gravity can be extended to the idea that the E_p, of an object at a particular height, can be converted to an equal amount of Kinetic Energy by allowing it to fall to its original position. This E_k is also equal to the work the object is able to do, for example, a diver doing work on the water as he lands.

- In climbing to the diving platform, the diver gains E_p by doing work against gravity. The amount of E_p is the same as the E_k the diver will gain in diving to the water level, at which point the

energy is transferred to the water. The diver does work on the water. The diver can feel this work, particularly during a bellyflop!

- The ideas of conservation of energy and isolated systems can also be raised. What are the factors that do not make it isolated?
- Another example popular with students that can be applied to this demo, is a water slide.

Evaluation

Group reports may be evaluated according to the following scale.

Design is flawed. Variables are not controlled. Little evidence of effort. Basic misunderstandings present. Written communication is difficult to follow. Mark = 1 = "Not acceptable"
Problem, hypothesis, procedure and observations are presented. Communication of experiment is adequate; however, some difficulties may reside with the control of variables or synthesis of key concepts that relate work to E_p. Mark = 2 = "Average"
Problem, hypothesis, procedure and observations are clearly presented. Communication of experiment is clear. Experimental design demonstrates an understanding of the concepts studied and limitation of variables. Mark = 3 = "Very Good"

Other Suggestions

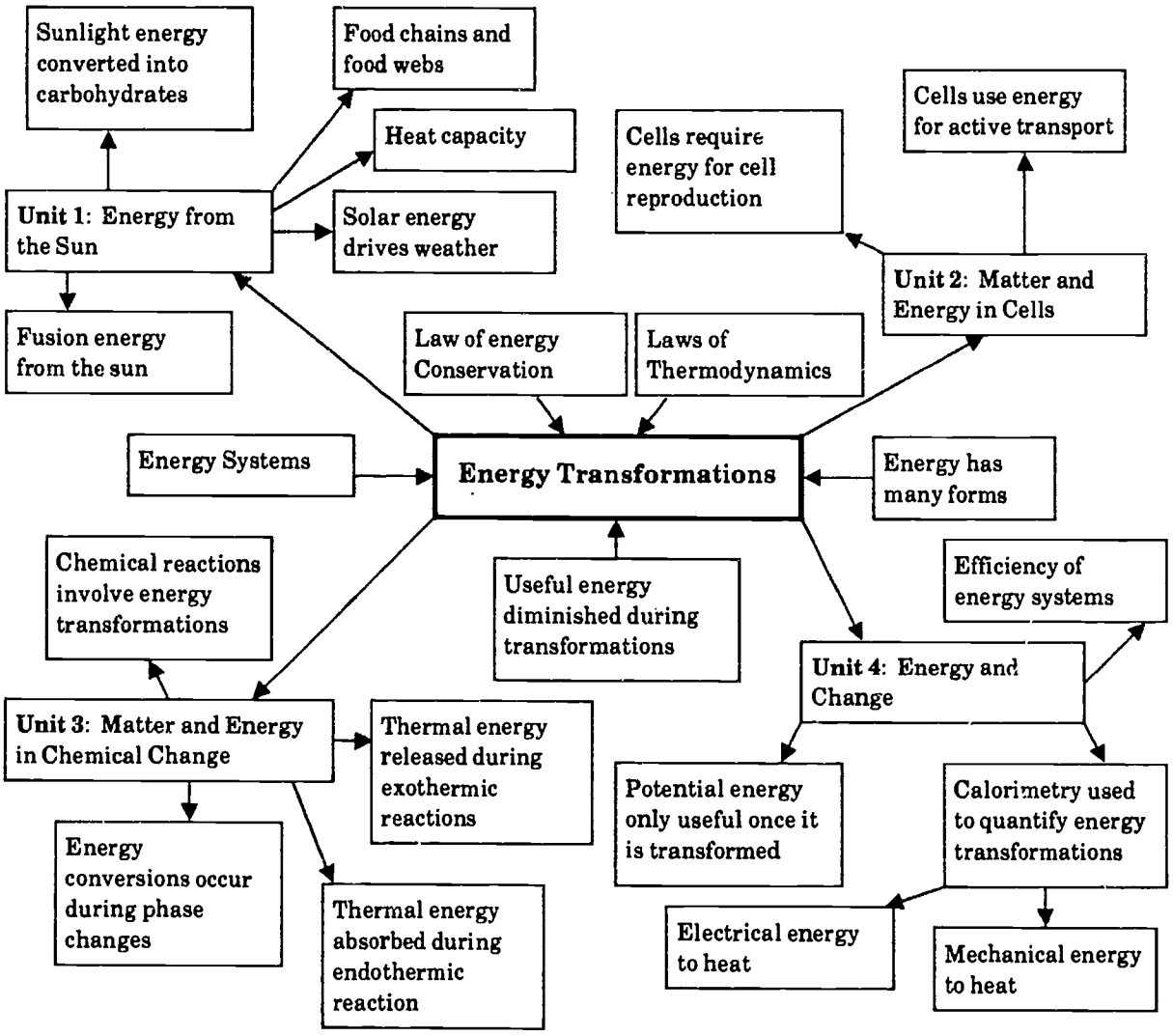
- This lesson provides another opportunity for performance assessment. Checklists, rating scales, personal interviews may be used as in previous units.
- Individual and group self-rating scales can be used to assess improvement over earlier group work.
- Have the groups compare their own evaluation of procedure and outcomes to the critique provided by another group.
- Have the students comment on the importance of collegiality among groups of different scientists working on the same problem.
- Have the students reflect on the importance of experimental procedure, i.e., it must be well thought out, revised if necessary, repeated to check reliability.
- Have the students reflect on the difference between practice and theory. Ask them "Is it possible to get experimental results that match perfectly with theoretical formulas?"
- Have the students research and write a short report on the energy transformations, and energy–work relationships involved in a favourite sport or athletic event. Refer to references given at beginning of this exemplar.

CONCEPT CONNECTIONS

by Bob Ritter

Energy can be explained as the capacity for doing work. In many ways students experience energy and develop a context for understanding it through its transformations. Unit 1, Energy from the Sun, focuses upon the role of radiant energy from the sun sustaining life and driving weather systems on Earth. In Unit 2, Matter and Energy in Living Systems, the processes by which energy is exchanged between living systems and their environment are studied. Unit 3 investigates the changes in energy that occur during chemical reactions. Unit 4 examines the different forms of energy and the principles that govern energy transformation.

Conceptual Framework 1: Developing an Understanding of Energy by Investigating Change



Energy can be classified in many different ways. The descriptions below will organize some of the different kinds of energy that your students will encounter.

- Chemical energy is the energy stored in chemical bonds. The energy is made available when the bonds between atoms are formed. The fire produced by burning wood, or the flash of light and explosion following the ignition of nitroglycerine provides two dramatic examples of chemical energy which has been released as new molecules are synthesized. Unit 1 describes the manner in which radiant energy from the Sun is transformed into carbohydrates by plants. Carbohydrates are often used by living things for energy. In Unit 2 energy is used for cell division and the movement of materials across cell membranes. In Unit 3 students have an opportunity to follow chemical reactions that occur in living and non-living systems. The relationship between energy and matter are strengthened as students discover how energy is involved in each change that matter undergoes. In Unit 4 students will bring greater focus on the quantitative aspects of changes in energy and matter.

- Electrical energy, like chemical energy, is associated with atoms. Small subatomic particles called electrons are capable of movement. In Unit 3, Matter and Energy in Chemical Change, students will have the opportunity to relate matter's atomic structure with energy.

- Nuclear energy is also associated with atoms. The energy is stored within the nucleus of the atom. Ironically, the smallest particles of matter can provide some of the greatest sources of energy. There are two different sources of nuclear energy.

    a. Fission energy is released when the nucleus breaks apart. During fission, subatomic particles move in all directions. Unfortunately, the energy is not always used for peaceful purposes. The atomic bomb that was dropped on Hiroshima released a force that was equal to 60 000 tons of TNT. Canada is one of the world leaders in the development of peaceful uses of nuclear energy.

    b. Fusion energy is released when hydrogen atoms are driven together to form helium. The energy of the Sun comes from the fusion. Fusion provides even greater energy than does fission. Energy from the sun is explored in Unit 1 of the Science 10 course. Your students will gain an understanding of how weather systems are driven by energy from the Sun.

- Light is a form of energy. Light moves in "energy packets", called photons or in waves. In Unit 1, students have an opportunity to study radiant energy from the Sun. The link between sunlight and photosynthesis provides a dynamic example of energy conversions, while establishing the relationship between energy and matter. In turn, the products of photosynthesis, carbohydrates, enable students to study the movement of energy through the food chain.

- Thermal energy is the result of molecular constant motion. Students will learn more about heat and temperature in Unit 1, Energy from the Sun, by calculating thermal energy as $Q=mc(T_2-T_1)$. Thermal energy provides the necessary scientific knowledge to explain warm and cold fronts, hurricanes, tornadoes and hailstorms. Students return to the concept of thermal energy in Unit 3, Matter and Energy in Chemical Change, as they study how energy is involved in each change that matter undergoes. Thermal energy can be measured in both endothermic and exothermic reactions. Unit 4, Energy and Change synthesizes many of the concepts introduced in previous units through the first and second laws of thermodynamics.

- Mechanical energy is often defined as the energy of movement. In Unit 2 students have an opportunity to investigate the movement of materials into and out of cells. Cellular energy is expended to transport matter by active transport. The opportunity to study division of labour by cells enables students to apply the laws of thermodynamics and principle of conservation of energy. Key concepts of Force, Matter, and Energy, introduced in the Grade 7 program are recalled and built upon in Unit 4, Energy and Change of Science 10. The unit extends the concepts of energy and energy conservation and energy transformation introduced in Unit 1 by bringing greater emphasis to quantification.

If asked, most students will indicate that they know what energy is; however, most will have great difficulty providing a definition. Energy is found almost anywhere they care to look. The chemical energy provided by food is converted into mechanical energy, which moves limbs, thermal energy, which warms the internal organs, or other forms of chemical energy, which maintain life processes. However, the study of energy systems is not restricted to food energy conversions.

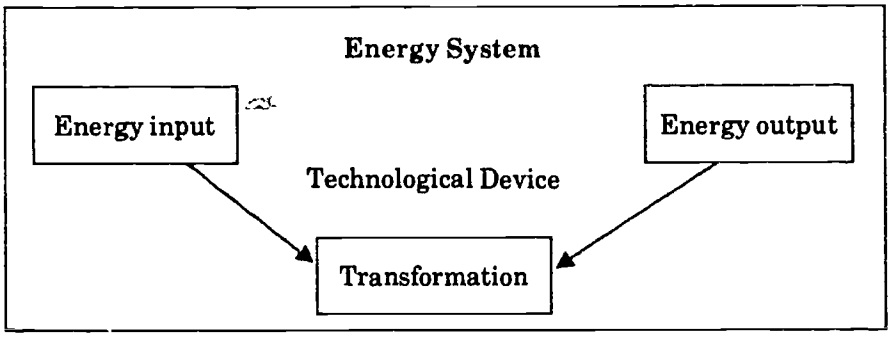
If asked, most students will indicate that they know what energy is; however, most will have great difficulty providing a definition.

Students should be encouraged to provide examples of energy transformations.

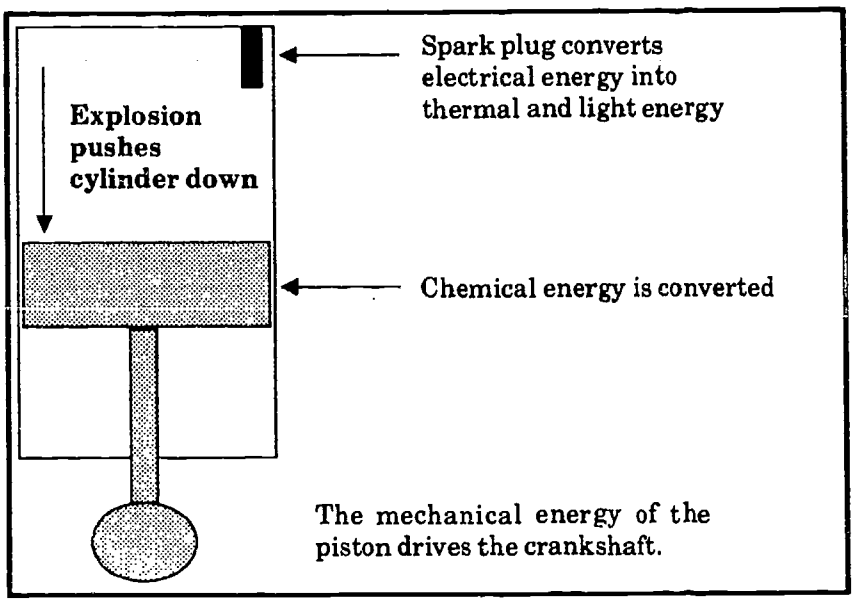
A flashlight converts chemical energy into light, another form of energy. A vacuum cleaner converts electrical energy into mechanical energy. Students should be encouraged to provide examples of energy transformations. Unit 4 students trace the flow of energy from the Sun to the lighting system of their school.

The **Law of Conservation of Energy** states that "energy can neither be created nor destroyed, but energy can change forms". The amount of energy within a closed system remains constant. In other words, the same amount of energy was present at the beginning of the universe and will continue to be present until the end of time. The law of conservation of energy has two essential parts. The first indicates that energy may take a number of different forms. The second indicates that if energy appears to be lost, it must be looked for in another form.

Misconceptions about energy often arise because students are not accustomed to thinking about the total amount of energy in the universe. Most confine their examples of energy to a particular event. Energy is most often investigated within **energy systems**. Energy systems involve the input of energy, energy transformations, and energy output. Energy conversion or transformation is most often accomplished by a technological device.



Many students who understand that the car requires energy to move, conclude that energy is created within the car. However, the energy is not created within the car. The energy must be added to the system. Students can be encouraged to consider the energy conversions taking place as they drive a car. The initial source of energy is gasoline, a form of chemical energy. Gasoline combines with oxygen in the cylinder of the car, the gases are compressed as the piston moves upward, and are ignited by the spark plug. The spark plug converts electrical energy into thermal energy, which in turn causes the gases in the cylinder to expand, thereby applying a downward force on the piston. By moving, the piston converts chemical energy into mechanical energy.



Energy is put into the system. The chemical energy of gasoline drives the piston. This is called **input energy**. The electrical energy that drives the spark plug is another form of input energy. Chemical energy is transformed into mechanical energy which moves the car. The mechanical energy used to moved the car is **output energy**. The car converts or transforms the chemical energy into mechanical energy.

Conceptual Framework 2: Developing an Understanding of Matter by Investigating the Kinetic Molecular Theory

Experiential learning provides little evidence that suggests that molecules in solids vibrate in a fixed position.

Matter is the constituent parts and the variety of states of the materials in the visual world. Inextricably linked with an understanding of the properties and structures of matter is the development of the concepts within a framework of the kinetic molecular theory—all molecules move. Although most students readily accept this scientific principle with regard to liquids and gases, most find it difficult to visualize when applied to solids. Experiential learning provides little evidence that suggests that molecules in solids vibrate in a fixed position. Students do not feel the molecules in a chair vibrate when they are sitting, nor do they feel the molecules in a book move when they are reading. The three phases of matter can be explained by the manner in which molecules move.

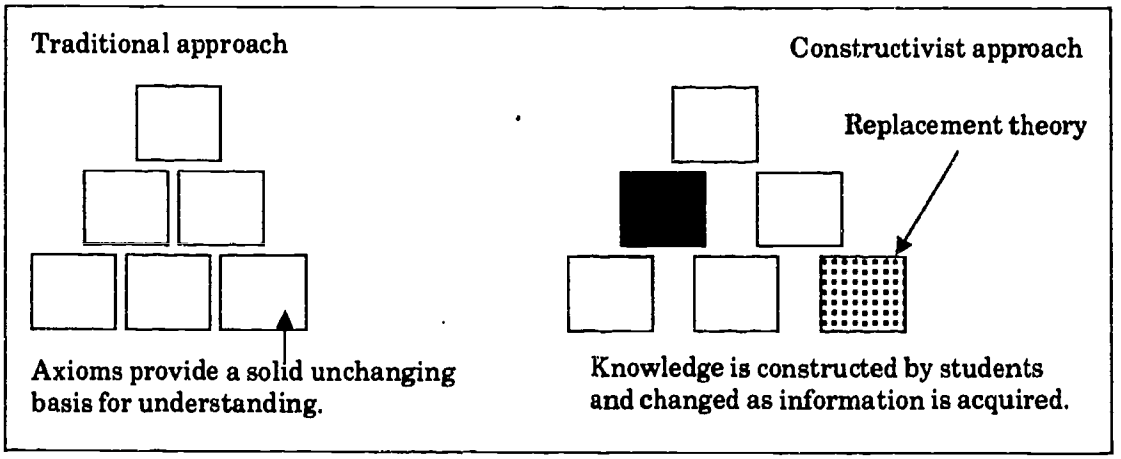
The experiential foundations for an understanding of the kinetic molecular theory are presented early in the junior high school program. As students progress, linkages are established among experiential observations culminating in the development of a formalized theory in Science 9. In Science 10, students begin constructing a framework for conceptualizing the properties and structure of matter from the kinetic molecular theory.

It is important to note that as students formulate their understandings and construct meanings, a number of alternate conceptions will arise. For example, many students will visualize the atom as a solid structure, a model long since abandoned by the scientific community. Although these students often acknowledge that spaces can exist between molecules, they have no lived-experiences which help them to visualize a relatively small area of protons and neutrons, the nucleus, surrounded by orbiting electrons. Most of what we call an atom is an area occupied by tiny, rapidly-moving electrons. Consistent with lived-experience, these students rationalize that matter is composed of atoms and that all of the atom must be solid. Others will explain the expansion of matter during heating by indicating that molecules, themselves, get larger. Once again, the notion that atoms are solid and solid objects expand when heated is grounded in lived-experience. Students know that metals expand when heated and metals are composed of molecules; therefore, they conclude that molecules expand when heated. Unfortunately, students borrow explanations and algorithms from lived-experience and apply them incorrectly to atomic structure, to develop an understanding of matter. In part, the nature of science component in the Science 10 program attempts to provide students with skills required to define the boundaries of the investigation.

The tendency to avoid potential misconceptions by providing a complete answer, usually amplifies the separation of science as "taught" from "lived-experiences". Students tend to accept scientific definitions of things such as "matter" or "energy" as having meaning in science classes, but often reject their meanings or fail to acknowledge them when dealing with technological applications beyond the domain of the classroom. An approach which stresses the linear, incremental building of scientific knowledge and fosters the idea that an understanding of science begins with a sequential linking of details only magnifies the problem. This view of scientific knowledge is analogous to building a pyramid, in that a solid base must be established before students can begin adding progressive levels of understanding. At the base of the pyramid are irrefutable truths or axioms which have been tested by time. The axioms become the factual basis on which an understanding is built. The recognition of linkages is often relegated to the teacher, and teacher-directed lessons dominate curriculum discussions and the organization of knowledge. Inherent within this approach is an underlying assumption that curriculum as "taught" parallels curriculums as "learned". A second assumption is that the correct axiom or truth is used to build an understanding.

The tendency to avoid potential misconceptions by providing a complete answer, usually amplifies the separation of science as "taught" from "lived-experiences".

Science 10 provides students with an opportunity to construct their own meanings, recognizing that future experiments and discussions will cause them to challenge some of their previous notions. The approach also acknowledges that prior learning has occurred. The junior high school program introduces the kinetic molecular theory. Previous formalized learning and everyday lived experiential learning are woven into a fabric of understanding.



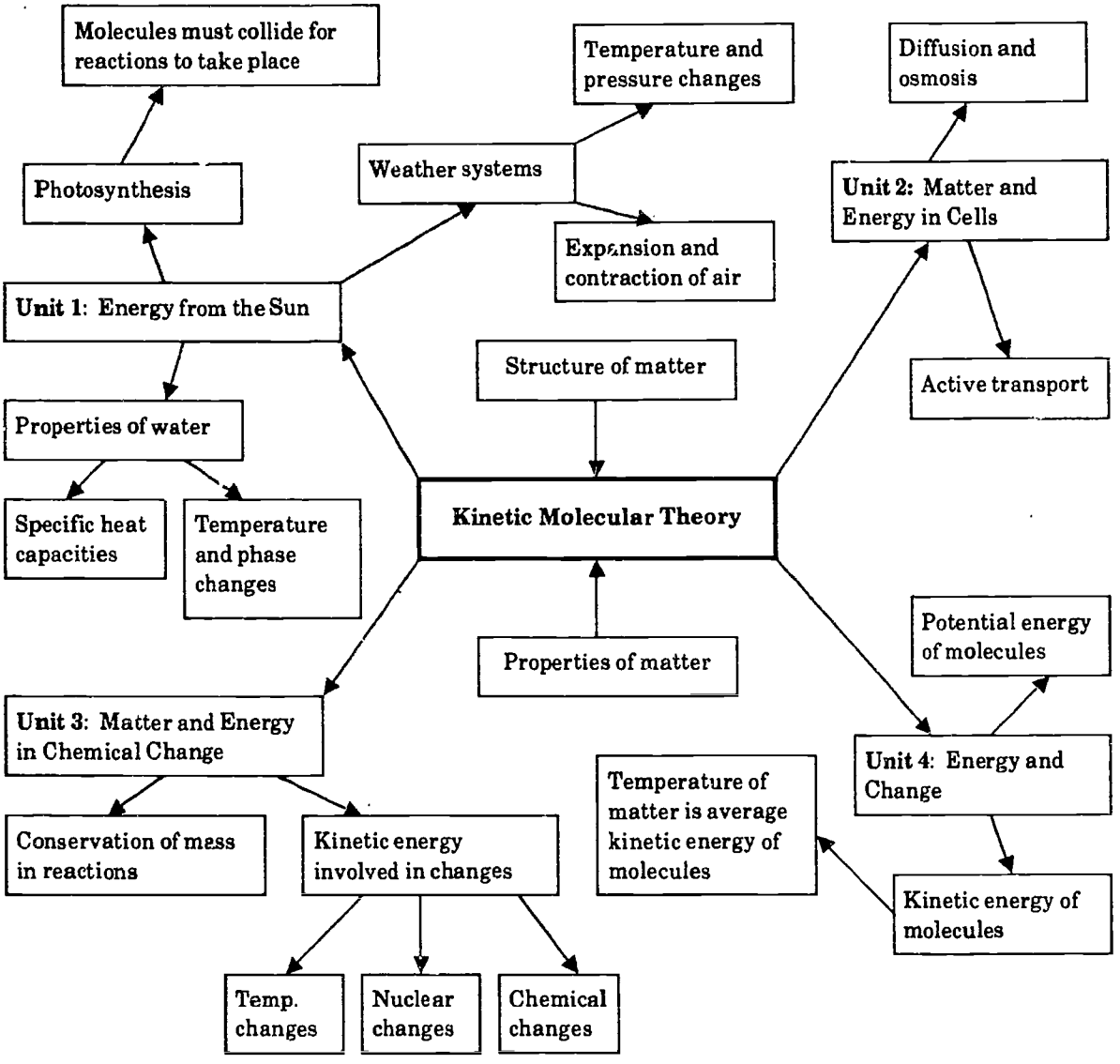
As students construct a knowledge base, gaps are found within their understanding. The traditional approach provides a solid basis prior to application and assumes that student learning parallels teaching. A constructivist approach requires the re-examination of beliefs and assumptions as knowledge is formalized. The foundations for understanding are either reinforced or changed as knowledge is constructed.

This approach also recognizes that some flaws will be encountered as students begin building a basis of understanding. Should we return to the analogy of the pyramid, students using this constructivist approach will identify difficulties or imperfections in the structural basis as they begin to build further levels of understanding. Existing assumptions will be challenged and scientific knowledge will be reorganized to provide a more solid basis. As each level of application is added, the theories and assumptions which underlie the framework of understanding must be re-examined to ensure that the knowledge base supports applications. Unlike a traditional view of science which presupposes that scientific knowledge is constructed on irrefutable axioms, this view presupposes that knowledge is tentative.

The emphasis placed on the big themes, such as matter, underscore the idea that the complete picture cannot be provided by the incremental accumulation of "facts".

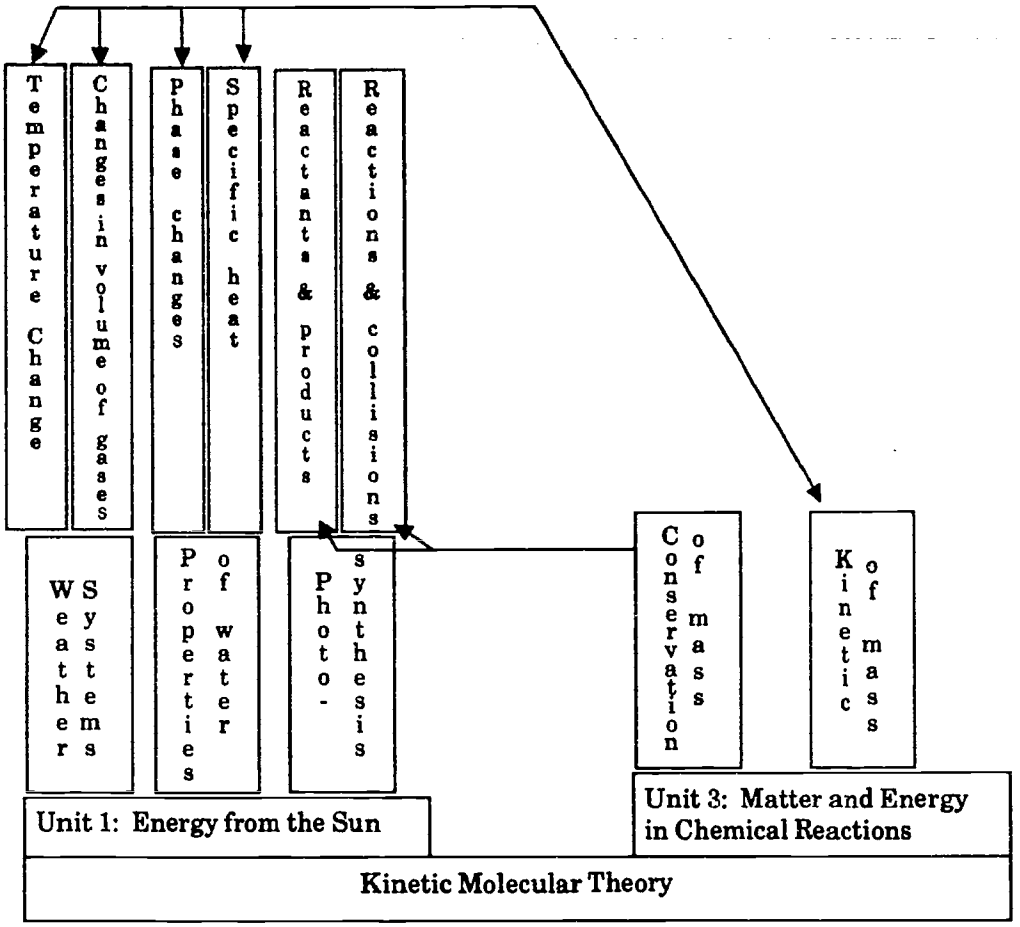
The emphasis placed on the big themes, such as matter, underscore the idea that the complete picture cannot be provided by the incremental accumulation of "facts". Beginning with large unifying concepts, such as the kinetic molecular theory, students develop frameworks to acquire knowledge about the properties and structure of matter. For example, the kinetic molecular theory provides the underpinnings for developing an explanation of why thermal energy causes temperature changes. As energy is added, molecules move faster and collisions occur more often. Temperature can be defined in terms of the average kinetic energy of molecules. However, in Chapter 2, students are confronted by a discrepant event—heat added to ice does not always cause a change in temperature. Phase changes are not accompanied by changes in temperature. The concept is revisited in Unit 3 as students investigate how energy is involved in physical changes of matter. In Unit 3, students are allowed to extend what they have learned about water to other chemical compounds and reconceptualize knowledge that they have formulated previously. An understanding of matter from the kinetic molecular theory is contingent on the development of the concept of energy conservation. Kinetic energy can be transformed into potential energy, which is energy of place or position. Similarly, potential energy can be transformed into kinetic energy. The behaviour of molecules is greatly influenced by kinetic and potential energy. Anomalies which address the uniqueness of water are inherently linked to an understanding of kinetic energy and the energy required to disrupt intermolecular forces (or potential energy).

The concept map below shows how the kinetic molecular theory provides a basis for constructing an understanding of the structure and properties of matter.



The kinetic molecular theory also serves as the springboard from which students begin investigating chemical changes, addressed in Unit 3. Molecules must collide for reactions to occur. In Unit 1, Energy from the Sun, students developed an awareness that the atoms of the reactants are used to make products, and therefore, the number of atoms in the reactants must equal the number of atoms found in the products. The concept of molecular motion and collisions is reinforced in Unit 2, Matter and Energy Exchange in Cells. Students learn that the movement of materials in a cell is dependent upon diffusion which can be defined in terms of Brownian movement: molecules are in a random ceaseless movement. An understanding of factors which affect the rates of diffusion are founded upon an understanding of the kinetic molecular theory—molecules with greater kinetic energy move faster. The need for transport systems, such as the circulatory system, by multicellular organisms can be explained by the kinetic molecular theory. Diffusion is a very slow process. Sufficient nutrient and waste transportation to meet increasing demands of organisms must be met by improving transport systems. Osmosis, the movement of water through a semi-permeable membrane, which appears later in the chapter, can be viewed as a specialized form of diffusion. The movement of water molecules occur because of Brownian motion. In Unit 4, students once again use the kinetic molecular theory to investigate the temperature of matter. Thermal energy flows from hotter objects to cooler ones. Transformations between kinetic and potential energy, as investigated within energy systems, provide a framework to interpret the first and second laws of thermodynamics. Energy cannot be created nor destroyed, only converted from one form to another.

It should be noted that the concept map represents many pyramids of knowledge which in turn have many interconnecting parts. In each case the kinetic molecular theory comprises the basis of each pyramid. The following diagram shows ways in which Unit 1, Energy from the Sun, is supported by the concepts in Unit 3, Matter and Energy in Chemical Reactions.



By no means are the interconnections shown on the concept maps or the pyramids of learning a complete picture. As information is gained, and technological applications are studied, greater integration occurs. But it is important to note that a student's understanding of the kinetic molecular theory will also change as information is synthesized. The changes do not always come from adding building blocks to the top of a knowledge pyramid, but from reinforcing and repairing the supporting structures.

COOPERATIVE LEARNING ACTIVITIES

by Pat Adams and Don Johnson

Cooperative learning strategies are significantly different from simple group work because they place each student in the role of both learner and teacher.

The new Senior High Science programs are ideally suited to extensive use of cooperative learning methodologies. Cooperative learning strategies are significantly different from simple group work because they place each student in the role of both learner and teacher. The expectation for each student is that he or she will not only learn given concepts through a student-centred approach but be the agent that facilitates the learning process for his/her peers.

Teachers recognize early on that one of the most effective means of learning comes through teaching and cooperative learning methodologies that place students in reciprocal teaching positions with fellow students.

The teacher's role in cooperative learning is both demanding and crucial to successful student learning. The teacher must select the appropriate methodology and organize students according to their numbers and the topic to be covered. While the students are engaged in the learning process, the teacher must also:

- act in a consultative role helping students in need of assistance due to confusion or inability to comprehend complex concepts
- ensure that groups of students stay on task
- maintain a timeline that encourages efficient learning with minimum downtime
- encourage students to document questions that arise so that they may be addressed in the whole group setting
- visit various groups and listen to the discussions to ensure that accuracy of in

When first using cooperative learning, teachers are encouraged to implement one learning strategy per month as opposed to attempting several different strategies all at once. This will allow both the teacher and students to become comfortable and internalize the process.formation is being achieved.

The selection of a cooperative learning strategy will depend upon the class objectives. Some structures are specifically designed to develop a concept while others are intended for mastery of concepts, team building, or development and improvement of communication skills.

Webbing—students write simultaneously on a piece of chart paper identifying main concepts, supporting elements and bridges representing the relation of ideas on a concept.

Round robin—each student in the group will in turn express his/her ideas and opinions relative to a topic. This encourages team-building skills and equal participation while developing a concept.

Jigsaw—each student in the group will become an "expert" on one topic (or one aspect of a topic) by working with members of other groups assigned the corresponding expert topic. Upon returning to their group each one will in turn teach the group and then group members are assessed on all aspects of the topic.

Fishbowl with Pair-Share—one half the class will sit in desks in an inner circle. The other half of the class will sit in desks in an outer circle. The students in the inner circle will discuss and defend issues relative to one side of a topic (e.g., nuclear energy). The students in the outer circle will listen (not participate) to the discussions of the inner circle. The two groups will then switch places and the new inner circle will then discuss the other side of the issue while the new outer circle listens. To finish the exercise a member of the outer circle will match up with a member of the inner circle in a pair share situation where each member can present differences and at the same time determine possible common ground to the argument.

Pairs Check—students work in pairs within groups of four. Within pairs the students alternate – one solves a problem while the other coaches. After every two problems the pair checks to see if they have the same answers as the other pair.

TITLE: PUBLIC HEARING—MAN'S INFLUENCE ON THE ENVIRONMENT

Learning Cycle:	Development, application and significance
Junior High Connection:	Grade 9, Unit 6, Environmental Quality
Science 10 Connection:	**Unit 1, Energy From the Sun**; *Visions 1*, Chapter 1
Learning Objectives:	To appreciate the complexities associated with ecological issues and economic, societal concerns.

Part A

Teacher Activity	Student Activity
Divide students into groups of three and have them brainstorm, "How have humans affected the natural balance of the biosphere?"	Following the brainstorming and selection procedures, students will begin to collect and organize data to support their position. (In addition they should be encouraged to determine the strengths of their opponents' position.)
Record the range of topics generated on the blackboard and have students select 3–5 topics (dependent on class size) for research projects and presentation.	Students will organize their data into a speech which each member will take a 1/3 primary responsibility for directing.
Each group of three will now indicate which topic and side they wish to represent (a lottery system may be needed to resolve disputes).	Each group will deliver its speech (max. 10 minutes) and may wear clothing/equipment appropriate to their role playing.
For each topic one group will represent industry, the other will represent environmentalists.	An independent panel of judges (fellow students) will judge the two speeches and evaluate them according to a checklist of pre-established criteria.
Topic presentation will be scheduled in the following week and each student in the group will be expected to contribute equally to the research and presentation.	
Try to make the issues revolve around local, specific issues, e.g., Daishowa Pulp and Paper, Oldman River Dam, Three Sisters Resort Development.	
Note: At least two class periods, preferably in the library, will be required for initial and ongoing research and sharing within the groups.	

Assessment and Evaluation

Both the group and individual presentations will be teacher-evaluated based on a criteria scale. This will be combined with the evaluation by the student panel.

TITLE: PUBLIC HEARING—MAN'S INFLUENCE ON THE ENVIRONMENT (continued)

Part B

Teacher Activity	Student Activity
Use a jigsaw approach to share project information between groups, thus avoiding the rather tedious, ineffective class presentations.	Student groups of 3 complete their written and visual projects.
Rearrange groups so that each new group of three has an individual from a different project group.	Groups meet to ensure a high degree of comprehension of project concepts among group members.
One more rearrangement, grouping students with two new project partners, will give each student five different project perspectives.	Each student in the group of three will give a brief synopsis reporting his/her group's project findings – the intent is for students to share their insights, relative to different organism comparisons, of how organisms are adapted to gather, transport and remove substances related to cellular needs.
	The visual presentation will be shared by each group member during the synopsis – this will require some articulation to avoid overlap between group members.

Assessment and Evaluation

Written projects evaluated to assess accuracy and thoroughness.

A checklist can be used to assess the model.

TITLE: CALORIMETER CONSTRUCTION

Learning Cycle:	Exploration, development and application
Junior High Connection:	Grade 7, Unit 4, Temperature and Heat Measurement; Grade 9, Unit 3, Heat Energy: Transfer and Conservation
Science 10 Connection:	**Unit 1, Energy From the Sun**; *Visions 1*, Chapter 2; Activities 2.2 and 2.3. This is an excellent lead-up to the above laboratory activities.
Learning Objectives:	To develop an effective calorimeter for Activities 2.2 and 2.3. To develop understanding of the concepts of heat radiation and capacity.

Teacher Activity	Student Activity
Divide the class into groups of three. • have students determine the features of an effective calorimeter • direct students to use materials that are readily available to them • students should read the lab activities to ensure their calorimeter will fit the needs of the experiment. Visit student groups as they proceed through the four-part process to: • pose questions to facilitate brainstorming • play the "devil's advocate" • maintain structure and on-task behaviour. **Note:** some materials for design (graph paper, ruler, compass ...) and for construction will have to be made available by the teacher.	Students in groups of three will brainstorm and record their ideas concerning the optimal features of an effective and practical calorimeter e.g., size, type of insulation, thickness of insulation, etc. Following a consensus-building discussion regarding calorimeter features, each group will now design, to scale, a calorimeter to be used in the upcoming Activities (2.2 & 2.3). The calorimeter should be labeled with an accompanying materials list. Each group will now exchange their design drawings with another group and after analyzing the other group's design provide written feedback about both the positive and negative features of the design. Each group will then consult on the analysis and make appropriate modifications to their design drawing. Homework assignment: • gather the appropriate materials for the construction of the group calorimeter • re-read Activities 2.2 and 2.3 in preparation for these labs. Some preliminary writing preparation may be required.

Assessment and Evaluation

The calorimeter can be graded using a checklist and scale to assess various features and overall construction.

TITLE: COOPERATIVE TEST PREPARATION

Learning Cycle:	Formative evaluation
Junior High Connection:	N/A
Science 10 Connection:	**Unit 1, Energy From the Sun**; *Visions 1*, Chapter 3
Learning Objectives:	To encourage effective study for tests. To provide students with peer feedback concerning test insights and preparation.

Teacher Activity	Student Activity
Homework assignment: students will construct three multiple choice questions and one extended response question for what they believe are the most significant concepts in Chapter 3.	Complete the homework assignment as neatly as possible.
The multiple choice questions should comprise one relatively easy question, one of medium difficulty and one relatively difficult question.	The following day, exchange questions with a partner and work individually on question completion.
Note: Students will require some instruction about how to construct a multiple choice question properly.	One student of the pair then lists his multiple choice answers and describes why he chose each answer. The "test-maker" partner now responds as to the correctness of the responses and provides a rationale if needed.
The long answer question will be designed to link the themes of energy, matter and change to one or more of the important concepts in Chapter 3.	The extended response answers are now read alternately and the partners then discuss the completeness and correctness of the answers (books may be used at this point).
The following day, group students into pairs and have them exchange questions.	Students now find a new partner and repeat this process.
After completion have them pair with someone different and repeat the procedure.	

Assessment and Evaluation

Questions can be collected and collated for student review.

A small number of the best questions can be incorporated in the summative test.

TITLE: IT'S ALIVE!

Learning Cycle:	Introduction, exploration/analysis
Junior High Connection:	Grade 7, Unit 1, Characteristics of Living Things
Science 10 Connection:	**Unit 2, Matter and Energy in Living Systems** – Introductory Activity
Learning Objectives:	To determine the unique attributes of living organisms. To understand the inherent difficulties associated with generalization. To develop a curiosity about the upcoming unity of study.

Teacher Activity	Student Activity
Challenge students with the assertion that a gasoline-powered engine is a living organism (running a weed-eater, lawnmower, etc., at this time is recommended – good ventilation and short duration of running time to reduce dangers of CO).	Pairs are assigned one of two options: • to support the assertion and brainstorm ideas that could be used to argue that the machine is a living organism, or • to challenge the validity of the assertion and brainstorm ideas that would prove the assertion wrong.
Students grouped in pairs and given one of two possible positions.	The "a" and "b" pairs form a group of four to debate this issue—the "a" group should attempt to provide examples of exceptions to prove their point.
Whole-group – teacher now plays the role of 'devil's advocate' and directs responses to the unresolved and successful points from student activity.	• one recorder should document unresolved or successful points made during discussion.
For example, students may suggest that since it cannot reproduce, it is not alive. A possible teacher response could be that worker bees and mules are alive but certainly not capable of reproduction. Or, the machine is not composed of cells; therefore, according to current scientific thought, it can be alive.	
Teacher response: are viruses cellular? Are they alive?	
Wrap-up—reconvene group discussion to itemize those features unique only to life forms.	
Advance teacher preparation is necessary to anticipate questions and formulate answers.	

Assessment and Evaluation

Not applicable.

TITLE: CELLULAR STRUCTURE AND FUNCTION—COMPARATIVE ANALYSIS

Learning Cycle:	Development and application
Junior High Connection:	Grade 7, Unit 1, Characteristics of Living Things
Science 10 Connection:	**Unit 2, Matter and Energy in Living Systems**; *Visions 1*, Chapter 4
Learning Objectives:	To develop an understanding of cellular structures, their functions and inter-relationships.

Teacher Activity	Student Activity
Groups of 3 students will research and assimilate information on three different cell structures. Direct students to gather information about each cell structure: • form • function • how the form is related to function • the interrelatedness of each cell structure to the other cell structure in terms of function. Group discussion will occur in order to establish competency of the knowledge base for the three cell structures. Instruct students to jigsaw and share their information – encourage note-taking and questioning. A culminating activity may be warranted where a class discussion led by the teacher creates a concept map linking the cell structures, their functions and interrelatedness.	Approximately one period will be required for students to research and develop a short written report on each of the three cell structures. Each student in the group will take responsibility for one cell structure and upon completion share his information with his group about form, function and their relationship. After developing group competence for each cell structure, the students in the group will brainstorm the idea of interrelationships that exist between the three structures. Students will now complete the jigsaw in order to share their information and gain new information concerning six other cell structures.

Assessment and Evaluation

Each group will construct 6–8 questions that centre around the significant aspects of their cell structure and distribute these to the class. Completion of the questions for homework, followed by a discussion period revolving around the answers and student concerns, will enable the teacher to assess student competency informally.

TITLE: PROJECT TWO JIGSAW

Learning Cycle:	Development and application
Junior High Connection:	N/A
Science 10 Connection:	**Unit 2, Matter and Energy in Living Systems**; *Visions 1*, Chapter 6 (culmination activity)
Learning Objectives:	To apply principles of cell biology in comparing unicellular and multicellular organisms. To create a model of a part of a system and understand its importance in enabling an organism to deal with energy, matter and change concerns.

PROJECT II

Unicellular and multicellular organisms require an input of matter and energy in order to bring about the changes necessary to sustain the living condition. As well these organisms must be able to secrete certain cell products to influence other nearby cells or organisms. Finally, waste materials are constantly being produced that must be excreted from the cell.

In multicellular organisms, the individual cells must carry on the above functions but they must also rely on "macro-systems" to gather, transport and remove substances related to the cell's needs. These needs revolve around the principles of the cell's need for energy and matter and its ability to cause change.

Prepare a visual presentation on one or more of the above aspects accompanied by a comprehensive, comparative analysis that explains how both unicellular and multicellular organisms are able to meet their needs as described above.

In this project each group will chose two different organisms (one unicellular and one multicellular) upon which they will focus their research and presentation.

TITLE: FORM AND FUNCTION PAIR-SHARE

Learning Cycle:	Exploration
Junior High Connection:	N/A
Science 10 Connection:	**Unit 2, Matter and Energy in Living Systems**; *Visions 1*, Chapter 6
Learning Objectives:	To learn and appreciate the "adapted" relationship between the structural make-up of tissues and their functions.

Teacher Activity	Student Activity
Provide students with a list of various vertebrate tissues and organs. Instruct pairs of students to select one tissue or organ as listed or another approved choice. Following the completion of the research have the students compare their form and function information. Upon completion, instruct students to re-pair one or more times to exchange the information with others concerning their final analysis.	One student of the pair will research the structural make-up of the tissue/organ and compile a list of structural features as well as a labelled diagram. The other student will research the function(s) of the tissue/organ and compile a descriptive list detailing the various functions that it performs. Student pairs now re-join and share their information. Following this exchange the pair attempts to find logical associations between the form or structural make-up of the tissue and the functions it performs. For example, one association between endocrine cell function and structure is the high proportion of rough endoplasmic reticulum and the secretion of protein-based hormones. After completing this final analysis, each member of the pair should join with a different student and complete a pair-share exercise.

Assessment and Evaluation

Not applicable.

TITLE: COOPERATIVE TEST REVIEW

Learning Cycle:	Formative and summative evaluation
Science 10 Connection:	Mid-term exam – completion of **Unit 2, Matter and Energy in Living Systems**
Learning Objectives:	To enhance student understanding of the concepts tested on a mid-term exam. To place responsibility with the students for their own learning, i.e., student-directed learning.

Teacher Activity	Student Activity
Mark student exams without an indication on the exams of what is right or wrong or the number of marks awarded for each answer. A separate tabulation must be recorded for each student's test.	Students will share their answers to exam questions, through test comparison and discussion in pairs.
Return exams to students with a percentage grade to indicate their exam result.	On an exam composed of one hundred multiple choice and ten extended response questions, each student may choose to alter answers to 20 of the M-C questions and two of the extended response questions.
Instruct students to select a partner and then have the students begin to re-evaluate their answers (the use of text and notes at this point is up to teacher discretion).	This may be a one- or two-period process – if two periods are used, then collect the exams after the first period.
Allow students to correct up to 20% of their answers for re-evaluation.	Students will hand in their exams for re-marking of the altered questions – these questions should be highlighted (use red pens) for marking ease.
* this methodology is particularly effective with major exams.	

Assessment and Evaluation

This process is best utilized with a significant exam other than a final exam. The actual recorded mark is based on the correct version of the test following the student pair analysis.

TITLE: INTERPRETATION OF PERIODIC TABLE—ITS STRUCTURE AND USE

Learning Cycle:	Overview, development, application
Junior High Connection:	Grade 9, Unit 5, Chemical Properties and Changes
Science 10 Connection:	**Unit 3, Matter and Energy in Chemical Change**; *Visions 1*, Chapter 7
Learning Objectives:	To become familiar with the periodic table and atomic structure. To note trends across the periodic table.

Teacher Activity	Student Activity
Have a group member list schematic periodic table on the board. Provide groups with blank periodic table and complete periodic table. Instruct groups to analyze periodic table and determine any pattern or trends evident. Have whole class discussion regarding group findings.	Group members will identify what information is given about each element from the periodic table. Using this information, students will examine periodic table and discuss rationale for placement of different elements in various groups or periods. Using blank period table, students will identify common threads that exist in the periodic table and use colour code to represent these areas (e.g., red shading for usable gases group VIII representing elements with complete outer shells). Each group will delegate one member to present Schematic periodic table to class.

Assessment and Evaluation

Group poster to be evaluated.

TITLE: EVIDENCE OF CHEMICAL AND PHYSICAL CHANGE

Learning Cycle:	Introduction, application, significance
Junior High Connection:	Grade 9, Unit 5, Chemical Properties and Changes; Grade 8, Unit 1, Solutions and Substances
Science 10 Connection:	**Unit 3, Matter and Energy in Chemical Change**; *Visions 1*, Chapters 7 and 9
Learning Objectives:	To investigate the physical and chemical properties of matter.

Teacher Activity	Student Activity
Provide student groups of 4 with large poster paper.	Group of 4 students, one pair of students within the group will brainstorm and record evidence of chemical change. Other pairs will do the same with evidence of physical change.
Direct groups to identify evidence that physical and chemical change has occurred during and after a reaction.	When brainstorming is complete, have one member of each pair switch with a member of another pair.
Suggest possible ways of presenting findings on poster paper.	Results of brainstorming sessions are reviewed with new partner (pair–share).
Have groups tape their poster paper on the front board for comparison.	Whole group will now present findings on poster paper.
Whole class discussion of group results.	Place poster on blackboard in front of class.

Assessment and Evaluation

Group poster will be evaluated.

TITLE: NUCLEAR WASTES FISHBOWL

Learning Cycle:	Application and significance
Junior High Connection:	Grade 9, Unit 6, Environmental Quality
Science 10 Connection:	**Unit 3, Matter and Energy in Chemical Change**; *Visions 1*, Chapter 9
Learning Objectives:	To appreciate both sides of the nuclear waste disposal issue. Culmination activity for Section 9.5.

Teacher Activity	Student Activity
Divide the class into two equal groups and assign one group the role of supporters of the new nuclear waste management facility in New Mexico. This group comprises subgroups of individuals representing the nuclear industry, the war department and some local entrepreneurs. Assign the second group the role of antagonists. This group is composed of local citizens, state department and municipal officials, as well as Greenpeace activitists.	Following the period of research, the antagonist group will circle their desks in a general discussion format and voice their views concerning the issue. The supporter group will form a ring outside the discussion group and listen quietly.
Assign each subgroup the responsibility of researching the issue and preparing a defense from their given perspective.	Groups now trade positions and responsibilities.
Allow one to two class periods for research. (You may want to use an article from *Science News*, Feb. 15, 1992 as an introduction to this activity.)	At the completion of the group discussion phase, students will pair with someone from the opposing group and, through consensus, identify the common and contentious areas that become apparent during the discussion.
Each group will be given 15 minutes to discuss their reasons for supporting or opposing the nuclear waste facility in New Mexico.	The teacher will now direct class input and itemize the points made on the blackboard.
	Note: A future class may be used to attempt to resolve this issue.

Assessment and Evaluation

Not applicable.

TITLE: TYPES OF CHEMICAL REACTION—IDENTIFICATION

Learning Cycle:	Exploration, development
Junior High Connection:	Grade 9, Unit 5, Chemical Properties and Changes
Science 10 Connection:	**Unit 3, Matter and Energy in Chemical Change**; *Visions 1*, Chapter 9
Learning Objectives:	To increase our awareness of the chemicals we use and how they may react. To predict results of chemical reactions.

Teacher Activity	Student Activity
Direct groups of 3 students to have each member research one of the three categories of chemical reactions.	Each member of group will select one category of chemical reaction, research topic by making notes and providing examples.
Provide students with additional resource materials if required.	Group members will jig-saw within their group (i.e., each student instructing the others on the findings of his/her research).
When research is complete, have students jigsaw within group.	Upon completion of each segment of jig-saw, group members should paraphrase the information they have received to ensure proper understanding of topic.
Hand out worksheet on identification of reaction types.	Each group member will do worksheet on reaction identification.
Post correct responses on board.	Compare answers with group and with answers posted by teacher.

Assessment and Evaluation

Not applicable.

TITLE: BALANCING EQUATIONS—PAIRS CHECK

Learning Cycle:	Development, significance
Junior High Connection:	Grade 9, Unit 5, Chemical Properties and Changes
Science 10 Connection:	**Unit 3, Matter and Energy in Chemical Change**; *Visions 1*, Chapter 9
Learning Objectives:	To understand the Law of Conservation of Mass. To predict results of chemical reactions.

Teacher Activity	Student Activity
Provide students with instructions on how to balance equations.	Student groups of 4 will work in 2 pairs.
Distribute worksheet on balancing equations.	Each member of pairs will alternate balancing problems on worksheet. Partner will coach and check answers as well as praise efforts.
Upon completion of worksheet, post correct answers on board.	Upon completing questions, each pair will compare their answers with other pairs of the group.

Assessment and Evaluation

Not applicable.

TITLE: ELECTRICAL ENERGY—PROBLEM SOLVING

Learning Cycle:	Application, evaluation
Junior High Connection:	Grade 9, Unit 4, Electromagnetic Systems
Science 10 Connection:	**Unit 4, Energy and Change**; *Visions 1*, Chapter 11
Learning Objectives:	To encourage effective study techniques. To provide the opportunity to deal with manipulating variables.

Teacher Activity	Student Activity
Assign practice problems (page 521) to prepare students for activity.	Each group member will create a word problem dealing with electrical energy. Write problem on an index card with solution on back of card.
Instruct students to develop their own word problems, write them on the index cards with solutions.	Members of group will pass their cards to each of the others in their group to solve.
There may be a need to review manipulation of variables within formulas.	Once group has solved all problems from group, they may exchange problem cards with other groups.
Instruct students to exchange problems with other group members.	
Groups to exchange card with each other and repeat "round robin".	
Collect "best" problems and save for test review.	

Assessment and Evaluation

Questions can be collected and collated for student review.

TITLE: COMPARISON—EFFICIENCY OF WATER HEATERS

Learning Cycle:	Exploration, application, significance
Junior High Connection:	Grade 8, Unit 2, Energy and Machines; Grade 9, Unit 3, Heat Energy: Transfer and Conservation
Science 10 Connection:	**Unit 4, Energy and Change**; *Visions 1*, Chapter 11
Learning Objectives:	Investigation of the Second Law of Thermodynamics.

Teacher Activity	Student Activity
Have groups design their own experiment for calculating efficiency of water heaters.	Groups to design experiment that will allow input and output energies to be calculated.
Check each group's procedure before allowing them to proceed.	Each group member will test one water-heating device (kettle, immersion heater, microwave) and collect group data.
Instruct groups to test three different water heaters and compare their efficiencies as a result of their input and output energy.	Group will reconvene and compare data. Efficiencies of each device will be calculated.
Ask students to recommend ways of improving efficiency of heaters.	Each group should prepare and present to class:
Conclude assignment with discussion of ideas presented by different groups.	• recommendations for improving the efficiency of each device • based on results gathered, make a statement regarding some aspect of energy use or consumption in society or the home (e.g., block heaters in automobiles).

TITLE: COMPARISON OF HYDRO-ELECTRIC AND COAL-FIRED ELECTRICITY GENERATION

Learning Cycle:	Introduction, exploration, significance
Junior High Connection:	Grade 9, Unit 4, Electromagnetic Systems
Science 10 Connection:	**Unit 4, Energy and Change**; *Visions 1*, Chapter 12
Learning Objectives:	To appreciate the positive and negative impacts of two different types of energy.

Teacher Activity	Student Activity
Instruct groups to research both hydro-electric generation and coal-fired electricity generation.	Group of four to work in pairs; each pair will research one of the two types of electricity generation.
Have students prepare a group Plus–Minus–Interesting chart based on research results.	The whole group will reconvene and share information.
Instruct groups to post their charts at front of the class.	The group will present findings on a P–M–I. (Plus–Minus–Interesting) poster.
Whole class discussion of group results.	Groups will post charts on front of board to be used by teacher in whole class summation.

Assessment and Evaluation

Group posters can be evaluated.

TITLE: ENERGY USE AND CONSERVATION

Learning Cycle:	Introduction, application, significance
Junior High Connection:	Grade 9, Unit 3, Heat Energy: Transfer and Conservation; Grade 7, Unit 4, Temperature and Heat Measurement
Science 10 Connection:	**Unit 4, Energy and Change**; *Visions 1*, Chapter 12
Learning Objectives:	To discover ways of reducing energy costs. To investigate the effect of the "green" attitude.

Teacher Activity	Student Activity
Instruct student groups of 3 to brainstorm areas of energy use in home (food, gas, electricity).	Student groups will identify areas of energy use and energy waste in their home.
Evidence of waste in home.	Determine method of calculating energy costs.
Teacher will have groups design an experiment to test both current energy use in the home and then energy consumption when the family is adhering to "green" attitudes.	Each group member will determine energy costs for a 2-day period at their home.
	Individual group members will next meet with family members and discuss realistic measures that the family could take in adopting a "green" attitude for a similar 2-day period. Energy costs are then calculated again.
	Whole group collects data and presents results on poster.
	Students will take class results back to family for feedback, designed to encourage permanent changes in energy consumption and waste.

Assessment and Evaluation

Each group member will hand in a copy of their own findings relative to their family's energy use, to be evaluated.

Group poster will be evaluated.

TITLE: THE EFFICIENCY OF MECHANICAL ENERGY CONVERSIONS

Learning Cycle:	Exploration/analysis
Junior High Connection:	Grade 8, Unit 2, Energy and Machines; Grade 7, Unit 3, Force and Motion
Science 10 Connection:	**Unit 4, Energy and Change**; *Visions 1*, Chapters 11–14
Learning Objectives:	To investigate the Second Law of Thermodynamics.

Teacher Activity	Student Activity
Instruct students to design and build a machine demonstrating three useful forms of energy.	A student group of 3 will blueprint their design for their machine, then construct the machine.
Critique each group's blueprint before allowing construction to begin.	The students will identify the point of each energy conversion and calculate the efficiency of each energy conversion.
Have students identify conversions and calculate efficiencies.	The group will then calculate the overall efficiency of their machine.
Wrap-up—have each group re-evaluate blueprints and mechanical results, and discuss modifications for increased efficiency.	The group will examine results and suggest possible change in design and construction.

Assessment and Evaluation

Project marks should be allocated for the following:

- blueprint design
- construction of machine
- presentation and interpretation of data.

TITLE: JIGSAW—END OF CHAPTER QUESTIONS

Learning Cycle:	Application, evaluation
Junior High Connection:	N/A
Science 10 Connection:	Useful with any assigned questions
Learning Objectives:	To reinforce the understanding of chapter concepts. To prepare for chapter examinations.

Teacher Activity	Student Activity
Using groups of 3: • assign end-of-chapter questions to each group with each group member answering 1/3 of the questions. Once students have researched their questions, have each member of the group responsible for certain questions (e.g., questions 1, 2 and 3), meet together with the teacher to discuss any areas of concern. Repeat this procedure with other group members. Instruct groups to jigsaw within group. **Note:** Teachers have the option of asking a group member to answer a question(s) in whole group situation to reinforce a particular concept.	Each group member will research/solve one-third of end of chapter questions. Group will jigsaw with each group member, going over solutions to the questions they answered. Each student will present their questions and responses to group members. Groups will expand responses if required and/or consult teacher for clarification.

Assessment and Evaluation

Not applicable.

LIBRARY RESEARCH IN SCIENCE 10

by Gloria Hodgetts and Jeff Goldie

Research projects that challenge students to build skills in planning, information retrieval, information processing, information sharing, and reflective evaluation are called for in the new senior high science programs. Science is an area rich in topics which students can research, especially so now that the new programs have a science, technology and society focus.

Background for the sample research projects that are provided in this section can be found in the *Senior High Science Teacher Resource Manual*, Section 3G (Effective Use of a Research Project) and in *Focus on Research*, produced by Alberta Education, 1990 (LRDC # 0XS01016, cost $3.85). It is recommended that teachers have a copy of *Focus on Research* as it is extremely useful in the planning of a research project.

This section provides some sample research activities for Science 10 classes. It begins with two simple projects in which students write a prcis of and critique an article on a science topic. This project could be used for any topic which would forward curriculum goals. For Science 10, Unit 1, Energy from the Sun, a two-part research activity on global warming begins with an article analysis and then moves into further research through topic identification and narrowing in global warming-related areas. Finally, two research activities for Unit 3, Matter and Energy in Chemical Change, are presented, "Technology and Energy Conservation" and "Water Quality." These activities are presented as springboards to stimulate the generation by teachers of research activities tailored to the needs of their students and the resources they have available in their libraries and communities.

Précis Project/Critique Project

Part A: Write a précis of an article.

Objectives:

- to encourage students to read scientific articles carefully
- to teach students how to write a précis
- to teach students how to use periodical indexes
- to help students follow subjects that are of interest to them personally
- to review bibliography format.

Students will summarize an article that is of interest to them, on either a recent technological development or a new scientific breakthrough. The teacher/ librarian will teach a mini-lesson on how to use a periodical index. In schools where the indexes are not available, the assignment could be changed so that a list of articles is available for students to browse through and choose. The bibliography at the end of this section may be helpful here. Together, the teacher/librarian and the teacher can teach students how to write a précis, explaining that it is a brief summary that maintains the author's point of view, the author's meaning, and the author's tone. This assignment could be done on a one-time basis or it could be a monthly required report that students complete as an out-of-class assignment.

Research Assignment – New Developments in Science and/or Technology

Name _____

1. Periodical Title: _____

   Publication Date: _____

2. Title of the article and page number

   _____

3. Author _____

4. Give the name of the person, persons or organization that have played a major role in this new development.

   _____

5. Write a one or two paragraph précis or summary covering the key points in the article.

6. The library assignment will be marked using the following guide:

Questions 1-4 Completed			4	3	2	1
Key Points summarized	6	5	4	3	2	1

Total Marks /10

Part B: Critique a Scientific Article

Objectives:

- to help students read with care
- to encourage students to engage authorities with a critical approach
- to widen student knowledge.

Another general library assignment is to ask students to critique a scientific article. It can be a good way to teach students to detect bias (environmental bias, scientific bias, economic bias), to check for accuracy by asking questions such as "Where did he get his facts? What were his sources? Was this an unbiased view? What was the writer's purpose?"

Critique of an Article on a Science Topic

After taking all the points below into consideration, give your opinion on a science topic article that interests you. Provide a copy of the article with your critique. The critique should be a minimum of three paragraphs long and due date is _____.

1. Author Credibility
   Are the authors who they say they are? Write down their credentials, if these are available.

2. Terminology
   Are the correct scientific terms used and explained accurately?

3. Date
   Check to see if the article is current.

4. Publisher
   Is the article appearing in a scientific journal, popular magazine or daily newspaper?

5. Content
   Is the information accurate—are there discrepancies, or errors in the theory presented? Is there enough evidence available to arrive at a conclusion? Is the author biased in the presentation of the data?

6. Bibliography
   Is a bibliography or list of references included?
   Are the articles cited correctly?

Science 10, Unit 1

Topic: Global Warming

Part A: Article Analysis

Global warming can be used as a research topic to introduce students and teachers to the numerous science magazines available in the library.

The teacher/librarian can use either the *Readers' Guide to Periodical Literature* or the *Canadian Periodical Index* to pull a variety of specific articles on global warming. Alternatively, the class can be taught how to do this. The time that the teacher wishes to spend on this activity will determine what method is used.

At this time, a mini-lesson on how to take notes can be helpful. A good way to do this is to model the process. The teacher/librarian or the science teacher could teach note-taking skills. Use webbing, outlining or a retrieval chart (*Focus on Research,* p. 46, 48, 49, 50). The students also need to learn how to do a proper bibliography. It is very important that they realize that sources must be acknowledged. Use bibliography cards. See the bibliography handout on page 11. It will help students keep track of the needed information.

Article Analysis – Global Warming

1. Read two articles on global warming.
2. Make notes on the articles.
3. Compare the two articles.
   What was the same?
   What was different?
   Were the authors authorities?
   Was there a bias? What was the bias? If so, what was the bias?
4. Choose a format to present the information you have gathered from the following list:
   a. oral presentation
   b. mind map
   c. poster
   d. newspaper/magazine article
   e. in any way you think will work
      (ask your teacher first)

Evaluation

Present the evaluation scheme with the assignment so that the student knows the evaluation criteria before beginning. Always try to write a short personalized evaluation as well.

Suggested criteria:

1.	Presentation shows that global warming is a concept that the student understands:	5, 4, 3, 2, 1
2.	Student comparison shows similarities, differences:	5, 4, 3, 2, 1
3.	Notes are complete:	10, 8, 6, 4, 2, 0
4.	Both articles are acknowledged, and bibliography is presented in a correct form:	5, 4, 3, 2, 1
	Total	/25

Topic Generation and Narrowing

Topic: Global Warming

Part B: Further Research

Use *Focus on Research*, page 78, as a guide.

Because the topic is so large, allow students a choice of topics, subject to your approval. Students can work on this project in groups of four. They narrow the topic and evaluate their choices before continuing the research. Ideally the teacher/librarian teaches a lesson on how to narrow a topic. Students ask themselves:

- Am I interested in the subject?
- Is the subject too difficult? Too broad? Too narrow? Too unfamiliar?
- Can I convey a sound understanding and specific details in the length required?
- Is there enough information available?
- Will the information be usable?

Possible topics related to global warming:

Carbon dioxide and global warming

Ocean's effect on climate

Description of the greenhouse effect

Deforestation in Brazil

Tidal flooding

Strategies to mitigate the effect of CO_2

The climatic role played by oceans

What new technologies can help reduce environmental pollution?

Chlorofluorocarbons (CFCs) and how they are used

What does scientific evidence say about ozone depletion?

What does scientific evidence say about the greenhouse effect?

What immediate action should be taken on the ozone problem?

What is the "Ice Age Prediction"?

How do volcanoes affect climate?

How do forests affect climate?

Reducing fossil fuels consumption

Science 10, Unit 3

Topic: Technology and Energy Conservation

This research unit can either begin or end with a field trip to an energy-efficient house, or a house that uses solar power.

Objectives:

- to teach students how to take notes using a variety of strategies
- to learn about ways of conserving energy
- to be able to voice an opinion and give reasons for it
- to reflect on the global ramifications of unwise use of energy.

Assignment

Choose a technology related to renewable energy sources. Describe the technology and give your opinion of its merit.

- Will it save energy?
- Will it prevent or cause environmental damage?
- What are the global ramifications? (Students can work in groups to answer each of the following questions in paragraphs.)

The group is to describe the approach that they used, realizing that they are to have research questions posed by a certain date and that these questions must be checked before they carry on. Notes will be marked at a due date as well. Each group will meet with the teacher or teacher/librarian for a conference to discuss their plan and evaluation criteria. The group will be coached through the research process, with the teachers providing help, encouragement and checks throughout. Whether or not the research is teacher-directed or student-directed will depend on the previous experience of the students and teachers. Due dates and more precise expectations will be included in a written assignment when they have been worked out. Some suggestions are that a minimum number of words be assigned with a requirement that at least three different sources be used. Have the group evaluate how well they worked together and how well the plan was carried out. The teacher will evaluate the written work, and peers will evaluate the sharing aspect. As much as possible the science teacher and the teacher/librarian can plan to use group work, finding out what the students already know and going from there. The team approach allows and encourages cooperative learning.

Possible Topics

Heat exchangers
Passive solar homes
Water pumping using photovoltaic cells
Solar water heater
Design considerations for Alberta
Biomass energy
Energy from wastes
Hydrogen computerized controls
Geothermal energy
Importance of building location
Hydro-electricity
Triple-glazed windows
Burning of wood
Solar cells
Windmills
Solar cars
Electricity from solar energy
Solar furnaces
Electricity from solar energy
Solar water heaters
Water pumping using photovoltaic cells

Evaluation Suggestions

1. Build checkpoints into the assignment and include them in the initial assignment.

2. The project uses a group approach and throughout both the science teacher and the teacher/librarian help the groups with all aspects of the research process – from planning to sharing. Skills should be reviewed or taught as required.

3. Students are aware that they check each step with their teachers before proceeding.

Adapt the evaluation suggested in Appendices B or *Focus on Research*, p. 82, to fit your needs.

Topic: Water Quality

The following sample research project is the result of several meetings between the teacher/librarian and the science teacher. In the course of those meetings the topic was selected, and relevant activities, demonstrations and projects were generated by brainstorming. It is intended to act as a guideline for organizing a research activity, and should not be thought of as "the right way!" There is no single best way to approach a topic, and the way it is used will depend to a large extent on the resources available, teacher expertise and teacher opinion.

A. Classroom Demonstration

The purpose of this demonstration is to introduce the concept of water quality, and to provide starting points for research activities.

Method

1. Samples of river water, standing water (puddle or slough), and tap water are collected.

2. The science teacher demonstrates or students perform a qualitative analysis for the presence of nitrate and coliform bacteria, two leading indicators of water quality. If possible, tests for the presence of heavy metals such as lead and mercury should be included as well.

3. Based on the results of the analysis, students are asked to produce generalizations about the nature of "clean" water.

B. Case Histories

The students are provided with case histories or examples of situations dealing with the effects of water pollution.

Note: The examples could be given in the form of readings or class discussions. One effective method to prompt student interest is to provide the case history in small pieces. Let the students draw their own conclusions before discussing what is the actual cause.

C. Group Research Activity

Using the above as a starting point, the students will choose a research topic related to water quality. Their task is to prepare a group project on either one of the suggested topics (Appendix A) or one of their own choosing to present to the class.

To direct student activities during this phase, students should be provided with the evaluation criteria before starting on their own, and they must know when each aspect is due.

The presentation has to be between 10 and 15 minutes and must involve all members of the group, in all stages of the research (i.e., planning, retrieval, processing and sharing).

1. Students use a minimum of three resources, and notes on these resources will be handed in as part of the evaluation process (10 marks).

2. A bibliography of the resources used must be provided (5 marks).

3. Students evaluate their own group based on the criteria shown in Appendix B (15 marks).

4. Classroom presentation is evaluated based on the criteria shown in Appendix B (5 marks).

Appendix A: Suggested Topics

Minimata disease
Lead poisoning – fetal growth
Cholera in 1991
Typhoid
Water treatment plants
Oxygen in Alberta lakes
Hazardous wastes
Issues related to water – destruction of forests, wetlands
Depletion of natural resources
Solid waste disposal
Swan Hills waste treatment facility
Acid rain
Contaminated drinking water
Disposal of dangerous substances in the ocean
Offshore development, including oil drilling
Natural disasters (volcanic eruptions, earthquakes, floods and droughts)
Marine animals
Pollution effects in specific bodies of water (Athabasca, Peace, North Saskatchewan rivers; Great Lakes)
How does a dam affect wildlife, fish, climate?
Oil spills
Chemical ponds
Mercury poisoning
David Schindler
Man-made contamination of groundwater
Pros and cons of water distillation

Appendix B
Adapted from *Focus on Research*, p. 84

Peer Evaluation of Oral Presentations

1.	Made introduction interesting	3	2	1
2.	Explained topic clearly	3	2	1
3.	Presented information in acceptable order	3	2	1
4.	Used complete sentences	3	2	1
5.	Concluded with a summary	3	2	1
6.	Spoke clearly, distinctly and confidently	3	2	1
7.	Maintained eye contact	3	2	1
8.	Maintained acceptable posture	3	2	1
9.	Kept the class's interest	3	2	1
10.	Used audio–visual aids well	3	2	1

Total divided by three so that this part of the mark is calculated out of 10.

Teacher Evaluation

The presenter handled questions and comments from the class effectively	5	4	3	2	1

BIBLIOGRAPHY CARD - BOOK

1. Library/Classification Number _____.
2. Author or editor (ed. - after name if editor) _____.
3. Title (volume if necessary) _____
   _____.
4. Place of publication _____.
5. Publisher _____.
6. Year of Publication _____.

BIBLIOGRAPHY CARD - MAGAZINE ARTICLE

1. Author _____.
2. Title _____.
3. Name of Magazine _____ _____.
4. Volume and Page Number _____.
5. Date _____.

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SCIENCE 10 RESOURCES

by Desiree Hackman and Pamela Shipstone

The following is a list of resources useful for implementing Science 10. The resources are categorized as follows:

- Basic Learning Resources
- Authorized Teaching Resources
- Support Learning Resources
- Other Resources
  - Videodiscs
  - Software
  - Laboratory Interfaces
  - Teaching Resources
  - Units 1, 2, 3, and 4 (print and non-print)

Basic learning resources are those student learning resources authorized by Alberta Education as the most appropriate for addressing the majority of learner expectations of course(s), substantial components of course(s), or the most appropriate for meeting general learner expectations across two or more grade levels, subject areas, or programs as outlined in provincial Programs of Study. These may include any resource format, such as print, computer software, manipulatives or video.
E.g., *Visions 1*

Authorized teaching resources are those teaching resources produced externally to Alberta Education for example, by publishers, that have been reviewed by Alberta Education, found to meet the criteria of review and to be the best available resources to support the implementation of Programs of Study and Courses, and the attainment of the goals of education; they have been authorized by the Minister. Teaching resources produced as service documents by Alberta Education, such as teacher resource manuals (TRMs), diagnostic programs and monographs, are authorized by definition.
E.g., *Climates of Canada*

Support learning resources are those student learning resources authorized by Alberta Education to assist in addressing some of the learner expectations of course(s) or components of course(s); or assist in meeting the learner expectations across two or more grade levels, subject areas, or programs as outlined in the provincial Programs of Study.
E.g., *Perspectives in Science Series*

Other learning resources are those learning resources identified by Alberta Education as useful for teachers in the implementation of a course(s) or Program(s) of Study, but which have not undergone review procedures in Alberta Education. Alberta Education does not accept responsibility for use of these resources with students. It is the responsibility of the teacher to determine the suitability and application of these resources.

When searching for resources to support the new science program you may want to check:

1. Other departments within your school. Often, resources are useful for ideas in more than one subject area. For example, Junior High Science, Environmental and Outdoor Education (EOE), Social Studies, Career and Life Management (CALM), or English.
2. School library for print or non-print resources
3. The regional resource centre or urban media centre for non-print resources (some authorized)
4. ACCESS for many authorized teaching and support video resources
5. LRDC for most authorized teaching and support print resources and some non-print resources

6. Government or non-government agencies for print and non-print educational materials or background information
7. Distributor for print and non-print resources

The basic resource will be available through the Learning Resources Distributing Centre (LRDC). A buyers guide is available from the LRDC at the following address:

Learning Resources Distributing Centre
12360 - 142 Street
Edmonton, Alberta
T5L 4X9
Phone (403) 427-2767

Note: The information included was the most recent information available at the time this Teacher Resource Manual was prepared.

***Annotations preceded by an asterisk have been supplied by the distributor.**

Basic Learning Resource

Visions 1

Format	Text
Annotation	Customized student resource for Science 10.
Price	$52.45
Author	Gage Educational Publishers
Distributor	LRDC 0SC10130

Visions 1

Format	Teachers Guide
Annotation	Customized for Science 10.
Price	$52.45
Author	Gage Educational Publishers
Distributor	LRDC 0SC10129

Authorized Teacher Resources

Climates of Canada (1990)

Format	Print	ISBN 0-660-13459-4
Annotation	This 176-page document is a valuable resource for the study of Canadian climate and environmental issues related to climate. The document includes descriptions of the climate of each province and territory, the factors that shape and control Canada's climate, and the elements of climate, e.g., rain, snow, tornadoes and hurricanes.	
Price	$14	
Author	Environment Canada	
Distributor	LRDC	0SC10133

One-Minute Readings: Issues in Science, Technology and Society (1992)

Format	Print
Annotation	Contains readings and questions related to issues in science, technology and society. Applications of science are raising tough questions and are creating problems that cannot be answered. The book is intended to give students practice in making the kinds of decisions they will experience in life. Students need a knowledge of science to find not the right answers but the best possible answers.
Price	Estimated: Student Book $10.50; Teacher Manual $7.90
Author	R. F. Brinkerhoff
Distributor	LRDC

Support Learning Resources

Perspectives in Science Series

Format	Videocassette (4 – 30-minute programs). The Program in Action; Biotechnology; Toxic Waste; Water
Annotation	Takes a major step toward the Science, Technology, and Society connection. Develops critical thinking about science and technology, examines basic application, and points out unforeseen problems or complications that often emerge as a consequence. Also available on laserdisc from Technovision. These videotapes contain docu-dramas with strong language and confrontation.
Price	Sold as a package only. See ACCESS catalogue.
Distributor	ACCESS BPN 321901-321904

Other Resources

This listing is not to be construed as an explicit or implicit departmental approval for use of the resources included. These titles are provided as a service only to assist school authorities to identify resources that contain potentially useful ideas. The responsibility to evaluate these resources prior to selection rests with the user.

Distributor information can be found on pages 51–53.
*** Annotations preceded by an asterisk have been supplied by the distributor.**

VIDEODISC RESOURCES

Videodiscs and multimedia libraries are distributed by companies in Canada. Some of these distributors are listed on pages 51–53.

BioSci II

Format: Videodisc

Annotation*:

- 2300 still photos, 100 film sequences with narration and 500 computer graphic diagrams in addition to the previous collection of 5000 visuals.
- Eight full dissections of the frog, fetal pig, earthworm, mussel, squid, crayfish, sea star and perch in labelled, unlabelled and quiz formats, and cat muscles.
- "Tour of the Cell"—a fantastic voyage around the organelles of a cell in 3D computer animation.
- Films of classic animal behaviour, continental drift, seasons, protein synthesis, physiology, and how to use a microscope.
- Comprehensive directory categorized by common name, scientific name, instructional concept and frame number. Each entry has a barcode which can be read by the Pioneer Barcode Reader.

Price: $549 U.S.

Distributor: Videodiscovery

Cell Biology

Format: Videodisc

Annotation*: Explores the inner workings of the cell. Includes 86 film segments and hundreds of still frames covering: cell types, cell constituents, mitosis, cytokinesis, fission and cell mortality. Live action footage includes segments on animal cells, plant cells, budding, multiple fission, protoplasmic streaming, migration of organelles, migration of pigment granules, flagellar motility, and adaptation to passive displacement.

Price: $549 U.S.

Distributor: Videodiscovery

Chemistry at Work

Format	Videodisc
Annotation*	• More than 800 photos and 3D computer graphics demonstrate practical applications in chemistry—processes in human and natural environments, actual photos of historical scientific figures and equipment, and chemical materials. • Approximately 30 short film/video segments, including the Hindenberg explosion, metallurgical processes and plant production of oxygen. • Students can learn balancing equations along with other mathematical problem-solving skills necessary for understanding chemistry. Instructors no longer need to spend valuable class time assisting with this difficult material. • Lab safety issues are covered, including handling acids, pouring, decanting, disposing of waste products and dealing with flammable materials. • The Periodic Table database presents a picture of each element, followed by the one or more common substances in which it is found. A printed, bar-coded Periodic Chart gives quick access to this database. • The User's Manual identifies each image with bar-codes and complete texts of the disc narrative.
Price	$549 U.S.
Distributor	Videodiscovery

Doing Chemistry

Format	Videodisc
Annotation*	This product of the American Chemical Society contains 122 experiments and demonstrations. The activities, first developed in 1983 by chemistry teachers supported by UCLA, have been revised in this version based on feedback from workshops and reviews by safety experts. The discs can be used to introduce the lab and show materials, equipment set-up, laboratory techniques and safety precautions. They may substitute for lab experiences for which time or equipment is not available. As a teacher training device, the series is invaluable since it presents time, materials, hints, hazards, disposal, introductory sets, question sets and answers, presentation questions, sample data, classroom copy masters, closure questions and practical applications. Includes HyperCard software, a laboratory interfacing program for the Apple II, and a 600-page Teacher's Manual with complete instructions for each experiment and textbook cross-references. Most of the manual's contents were selected and designed by high school teachers.
Price	$549 U.S.
Distributor	Videodiscovery

Dream Machine I: The Visual Computer

Format	Videodisc
Annotation*	Explores the development of the computer as a visual instrument that combines the objectivity of photography, the subjectivity of painting, and the gravity free motion of hand-drawn animation. The disc contains 112 computer-animated motion sequences.
Price	$48.70
Distributor	LRDC 0AR07009

Dream Machine II: Computer Dreams

Format	Videodisc
Annotation*	Celebrates state-of-the-art computer imaging, circa 1988. It looks at computer-aided design, architectural simulation, medical and biological simulations, flight simulation, space exploration, entertainment, and fine art.
Price	$48.70
Distributor	LRDC 0AR07010

Frog Anatomy and Physiology Library

Format	Videodisc
Annotation*	Featured on one videodisc, this program contains slides, diagrams, and movie clips which provide a detailed review of amphibian anatomy and physiology and offers an alternative to dissection in the classroom. Included are more than 150 slides, 50 diagrams and 34 movie clips. Slides display detailed information about subjects such as embryology and metamorphosis, as well as major tissues, bones and muscles. Movie clips include studies of anatomy and physiology of all major organs and systems and show a variety of frogs in their natural habitat.
Price	Multimedia Library $595 U.S.; Frog Anatomy Discs only, $345 U.S.
Distributor	Optical Data Corporation

Garbage: The Movie – An Environmental Crisis

Format	Videodisc (24 min.)
Annotation*	A fascinating look at the problem of the environment and solid waste, as well as some promising solutions, presented in the vernacular of students. Our young host leads us to landfills and incinerators, to recycling plants and composting yards. Behind the scenes, we explore the reasons landfills are closing, discover how the garbage crisis is creating pollution, and search for the roots of the problem. We discover some hopeful solutions: recycling, reusing, reducing use, consumer choices and organized action.
Price	$470
Distributor	McIntyre Media Limited

Geology and Meteorology

Format	Videodisc
Annotation*	Contained on one videodisc, this program provides more than 7200 slides, a 400-term glossary and 34 movie clips for a thorough review of earth geology. The slide collection includes plate tectonics, volcanic formation and the many ongoing weathering processes affecting the Earth. Movie clips examine volcanoes including Vesuvius and Heimaey Island; tectonics, including the dynamics of continents and evolution of North America; meteorology, including rain and cloud droplets, thunderstorms, hurricanes and tornadoes; weathering, including glacial melting, erosion and cratering; and rocks and minerals, including composition, formation and lunar rock samples.
Price	Multimedia Library $995 U.S.; Discs only, $595 U.S.
Distributor	Optical Data Corporation

Global Warming: Hot Times Ahead

Format	Videodisc (23 min.)
Annotation*	Engaging, offbeat young Marc Price (from television's Family Ties) leads the way through this exploration of the Global Warming phenomenon and some of the devastating changes that may result. We learn about greenhouse gases and how they are produced by human activities, chiefly the burning of fossil fuels. The film illustrates how we can slow the build-up of greenhouse gases in the short term by conserving and using gases efficiently; how in the long term, we must develop new ways to use the sun's energy.
Price	$470
Distributor	McIntyre Media Limited

The Living Textbook: Principles of Biology/Life Science

Format	Multimedia/videodisc
Annotation*	A two-videodisc set, this program contains more than 2700 slides, 150 diagrams and 163 movie clips covering molecular, cell, plant, animal and human biology. Included are a 650-term glossary and 1000 of Oxford Scientific's best photos. Movie clips cover detailed biological processes such as: cell biology, from protein synthesis to living cells; reproduction, from spermatogenesis to frog development; human biology, covering a whole range of systems and their functions; protist biology; fungi, from bread mold to zoospore release; plant reproduction and life cycles; invertebrates; and vertebrate biology, including behaviour and interaction. Molecular, Cell and Human Biology (Sides 1 and 2) has curricular fit to Science 10–20–30 and Biology 20–30. Plant and Animal Biology (Sides 3 and 4) offer a comprehensive survey of life science. Sides 3 and 4 do not have direct curricular fit to the new senior high science programs but they could be used for reference or extension activities.
Price	Multimedia Library includes two videodiscs, print directory, bar-coded lesson plans, interactive software for Apple IIGS and Macintosh computers and interface cable – $1495; Principles of Biology, Videodiscs only $995 for 2 or $595 each.
Distributor	Optical Data Corporation

The Living Textbook: Principles of Physical Science

Format	Multimedia/videodiscs
Annotation*	A two-videodisc set, this program provides more than 2500 slides, 300 diagrams, a 325-term visual glossary and 90 movie clips for a comprehensive survey of physical science. Movie clips cover the structure of matter, including atomic theory and radioactivity; states of matter including solids, liquids and gases; the conservation of energy; mechanics, including Newton's and Kepler's laws with examples; wave motion; light and sound, including refraction, polarization and energy levels; electricity and magnetism, including an electrochemical cell, magnetization, electromagnetics and aurorae observations. Matter, Motion and Forces (sides 1 and 2) and Waves, Electricity and Magnetism (sides 3 and 4) offer a comprehensive survey of chemistry and physical science. Both videodiscs have curricular fit to Science 10–20–30, Chemistry 20–30 and Physics 20–30.
Price	Multimedia Library includes two videodiscs, print directory, bar-coded lesson plans, interactive software for Apple IIGS and Macintosh computers and interface cable – $1495; Principles of Physical Science, Videodiscs only $995 for 2 or $595 each.
Distributor	Optical Data Corporation

Our Environment (1990)

Format	Videodisc
Annotation*	Inspire environmental understanding at the junior and senior high school level with this amazing treasury of 6000 colour photos sequenced with explanatory captions, maps, diagrams and film segments. The disc, carefully organized to allow easy Level I use, includes: • The four spheres of air, water, land and organisms. • A focus on important environmental problems—such as acid rain, energy usage, climate change, desertification, wetlands loss, tropical deforestation, oil spills, nuclear power and weapons, soil erosion, solid waste, species extinction, asbestos and water pollution. • A Visual Glossary and Panorama illustrating over 700 environmental terms and surveying the globe with captioned photos.
Price	Videodisc – $395 U.S.; Teacher Manual – $30 U.S.; Student Manual – $15 U.S.; HyperCard Stacks – $70 U.S.
Distributor	Optilearn

Periodic Table and Periodicity: Chemistry Series

Format	Videodisc and Guide (23 min.)
Annotation*	Grades 10–12. Each of the chemical elements has its own unique physical and chemical properties. The fact that there is a pattern to these properties led to the development of the periodic table, a remarkable way of organizing these patterns. Animation succinctly develops the relationship between the electronic structure of an atom and its properties, demonstrating clearly why there are families of elements and gradual changes in the properties of elements.
Price	$210
Distributor	Coronet

Perspectives in Science

Format	Videodisc
Annotation	The Perspectives in Science series consists of three one-hour interactive videos which explore the topics Biotechnology, Toxic Waste, and Water. Each video starts with a drama which introduces the issues examined in the program. Each video illustrates the STS connections of a given topic through discussion, analysis, perspectives and alternatives. Master Menus guide the viewer through each program, and a time code reference is given for the Science, Technology and Society components of the program so that information can be accessed easily. The series also includes a 30-minute introductory video, The Program in Action.
Price	$345
Distributor	Technovision

Physics and Automobile Collisions

Format	Videodisc
Annotation*	Using the attention-grabbing footage of car collisions, this disc provides a graphic and entertaining way for students to study the principles of momentum, Newton's Laws, and mechanical energy. Collisions are recorded in 11 chapters on the disc, while an audio track emphasizes key concepts during the motion. Students then analyze the action using freeze-frame control, and measure the screen to gather data. Appropriate for three levels of physics instruction: descriptive physics, the algebra/trigonometry course in college physics, and calculus-based engineering physics.
Price	$225 U.S.
Distributor	Videodiscovery

Physics of Sports

Format	Videodisc
Annotation*	This detailed record of over 20 athletic events, filmed expressly for scientific analysis, provides visual data from which quantitative data may be collected by biomechanics, kinesiology and physics students. The videodisc is used to step through actions in 1/30 second intervals. Using a sheet of clear acetate over the image on the monitor, students can study each position and collect data on such physical principles as linear motion, projectiles, energy transformation, momentum, impulse and time. This is an ideal way to apply physics to real world problems. Includes a student handbook and a teacher's guide detailing how the disc may be used in a typical physics curriculum, directory of the images, formulae and step-by-step instructions.
Price	$549 U.S.
Distributor	Videodiscovery

Sightlines

Format	Videodisc
Annotation	Authorized for Senior High Art.
Price	$136.50 includes laserdisc, cover, mini-catalogue. Detailed $13.95. Both are SEICAG eligible.
Distributor	LRDC Laserdisc 0AR07006; Detailed Catalogue 0AR07007

SOFTWARE

Interactive Physics

Format	Macintosh Note: New version to be released in June 1992.
Annotation	Interactive Physics allows users to create experiments by drawing objects on a screen. It lets users adjust physical quantities (such as mass, friction, elasticity and gravity) to explore their effects on an experiment. Each physics interaction (set of exercises) consists of a series of activities which involve modifying and observing experiments. The results of the experiments are then analyzed both mathematically and conceptually. Because Interactive Physics visually simulates real experiments, it allows students to learn by exploring and hypothesizing. 1. Stability 2. Free-Fall in One Dimension 3. Relative Velocity and Acceleration 4. Newton's First Law 5. Newton's Laws: Mass and Acceleration 6. Mass and Weight 7. Uniform Circular Motion 8. Rotational Kinematics 9. Centre of Mass 10. Linear Momentum 11. Collisions on an Air Track 12. Two-Dimensional Collision 13. Elastic Potential Energy and the Work Done by a Spring 14. Elastic Potential Energy, Gravitational Potential Energy and The Work Done by a Spring 15. The Spring-Launched Ball 16. Power
Price	$249
Distributor	Contact your local software distributor.

LXR Test

Format	Macintosh
Annotation	Test-generating program. There are three versions of the program: Personal, Professional and Scoring Editions. The item banks from ADLC have been created on the Scoring Edition of LXR to take full advantage of its additional features; however, the item bank will also work with the Personal and Professional Editions. There are some 'challenges' associated with using the Personal edition, but this may not be a problem depending on your level of use.
Price	Personal – $599 U.S. (Site License) Professional – $799 U.S. (Site License) Scoring – $999 U.S. (Site License)
Distributor	Logic eXtension Resources

LABORATORY INTERFACE

Champ II

Format	IBM PC and PS/2 (Mac version will be released later this year)
Annotation	Champ II allows you to perform/analyze experiments using probes, software and computer hardware.
Price	Contact Merlan Scientific for price list.
Distributor	Merlan Scientific

Leap

Format	IBM/IBM Compatible/Apple II/Mac
Annotation	Leap allows you to perform/analyze experiments using probes, software and computer hardware. Interdisciplinary Lab Pac (Physics/Chemistry) and Biology and Principles of Technology (Applied Physics) Lab Pac are available. Lab Pacs include manuals, interface card, software and several probes/cables.
Price	Contact Quantum Technology for price list.
Distributor	Quantum Technology, Inc.

Personal Science Lab

Format	IBM/Compatible
Annotation	PSL allows you to perform/analyze experiments using probes, software and computer hardware.
Price	Contact local distributors for price list.
Distributor	Computerland

OTHER TEACHING RESOURCES

Canadian Environmental Education Catalogue: A Guide to Selected Resources and Materials (1991)

Format	Print
Annotation	Contains a comprehensive list of environmental education resources.
Price	$20 Main Volume; $40 2-year subscription (main volume plus supplementary volumes, 1 every 6–8 months)
Distributor	Pembina Institute

Chemistry, Third Edition (1988)

Format	Print	ISBN 0-07-555235-3
Annotation	Written at an introduction college level, this text gives a thorough treatment of basic chemistry concepts. In addition, the "Chemistry in Action" sections show the relevance of chemistry to medical, biological, and engineering fields.	
Price	$44.84 U.S.	
Author	Raymond Chang	
Distributor	McGraw-Hill Ryerson Ltd.	

Chemistry: A First Course (1988)

Format	Print	ISBN 0-201-17880-X
Annotation	This introductory high school chemistry text presents the basic concepts of chemistry in a clear and understandable manner, using numerous practical examples. The text examines some of the major social issues confronted by the Canadian chemical industry.	
Price	$34.20	
Author	Geoffrey Rayner-Canham, et al.	
Distributor	Addison-Wesley Publishers Limited	

Chemistry: A Second Course (1988)

Format	Print	ISBN 0-201-17885-0
Annotation	This text is written for a senior-level high school chemistry course. The relevance of chemistry is emphasized by examining some current environmental questions.	

Price	Not available
Author	Geoffrey Rayner-Canham & Arthur Last
Distributor	Addison-Wesley

Clouds in a Glass of Beer: Simple Experiments in Atmospheric Physics (1987)

Format	Print ISBN 0-471-62482-9
Annotation	Contains experiments for diffusion, heat transfer, conservation of energy, kinetic potential, solar radiation, the freezing point of water, cloud formations.
Price	$12.95 U.S.
Author	Craig F. Bohren
Distributor	John Wiley and Sons, Inc.

Conceptual Physics: A High School Physics Program (1987)

Format	Print ISBN 0-673-39847-1
Annotation	Physics is treated conceptually rather than mathematically in this text. The physics concepts are present in English and equations are used as guides for thinking, rather than recipes for algebraic problem solving.
Price	$19.44 U.S.
Author	Paul G. Hewitt
Distributor	Scott Foresman

Focus on Research: A Guide to Developing Students' Research Skills (1990)

Format	Print
Annotation	This document outlines a resource-based research model that helps students manage information efficiently and effectively, and in this process, to gain skills that are transferable to all school and work situations. This model provides a developmental approach to teaching students how to do research.
Price	$3.60
Author	Alberta Education, Curriculum Branch
Distributor	LRDC 0XS01016

Fundamentals of Physics: A Senior Course (1986)

Format	Print	ISBN 0-669-95047-5
Annotation	This text is written for a senior-level high school physics course, and provides a thorough examination of basic physical concepts. It is an algebra-based physics text with many examples drawn from everyday life.	
Price	$44.95	
Author	David G. Martindale, Robert W. Heath, and Philip C. Eastman	
Distributor	D.C. Heath Canada Ltd.	

Heath Chemistry, Canadian Edition (1987)

Format	Text Print – Teacher's Edition	ISBN 0-669-95289-3 ISBN 0-669-95290-7
Annotation	This high school chemistry text focuses on student understanding of basic chemistry principles, with special emphasis on proportional reasoning in chemistry calculations	
Price	$49.95 Text $64.95 Teacher's Edition	
Author	J. Dudley Herron, et al.	
Distributor	D.C. Heath Canada Ltd.	

Invitations to Science Inquiry (1990)

Format	Print	ISBN 1-878106-00-7
Annotation	Contains several demonstrations related to each of the science disciplines.	
Price	$40 U.S.	
Author	Tik Leim	
Distributor	Science Inquiry Enterprises	

Levitating Trains And Kamikaze Genes: Technological Literacy for the 1990's (1991)

Format	Print	ISBN 0-060973692
Annotation	A guide to technological literacy with a list of topics on space technology, biotechnology, computer literacy, energy, superconductivity, high technology, health and transportation.	
Price	$8.95 U.S.	
Author	Richard P. Brennan	
Distributor	Harper Collins	

Media Literacy Resource Guide (Intermediate and Senior Divisions) (1989)

Format	Print
Annotation	Provides activity ideas using film, television, advertisements and other media for senior high classes. Also, presents compact summaries of the element to analyze critically in each medium.
Price	$9.25
Author	Publications Ontario
Distributor	LRDC 0SS07075

The Nature of Life (1989)

Format	Print ISBN 0-07-557035-1
Annotation	This introductory college level text is clearly written and richly illustrated. The book is organized around three unifying themes: • living things take in energy to maintain their internal order and organization; • living things undergo reproduction so that the species continues after the individual ceases to exist; and • living organisms are able to adapt to changing environments.
Price	$43.08 U.S.
Author	John H. Postlethwait & Janet L. Hopson
Distributor	McGraw-Hill Ryerson Ltd.

Physics, Third Edition (1988)

Format	Print ISBN 0-471-85221-X
Annotation	This text is written for introductory college level, with particular emphasis on applications of physics principles in the life sciences. It makes extensive use of examples involving biological and chemical systems and alternative energy sources.
Price	$59.95 U.S.
Author	Joseph W. Kane & Morton M. Sternheim
Distributor	John Wiley & Sons

Physics: Principles with Applications, Third Edition (1991)

Format	Print	ISBN 0-13-672510-4
Annotation	Written at an introductory college level, this text uses algebra and elementary trigonometry, but not calculus. The applications of physics concepts include a wide range of examples from biology, medicine, architecture, technology, Earth sciences, the environment and daily life.	
Price	Not available	
Author	Douglas C. Giancoli	
Distributor	Prentice-Hall Inc.	

Problems in Chemistry (1990)

Format	Print	ISBN 0-07-452665-0
Annotation	Each chapter contains a summary of key concepts and several questions related to the concepts. Part B gives complete answers to some questions, Part C gives only the answers.	
Price	Not available	
Author	Roland Smith	
Distributor	McGraw-Hill Ryerson Ltd.	

Professional Development Inservice Modules

Format	Print	
Annotation	System-Based Development Model for Workshops – A Planning Manual Teaching for Thinking STS Teaching Strategies Controversial Issues in the Science Classroom Focus on Research Science 10 Activities: A Hands-On Sampler Performance Assessment in Science 10 Technology and Media in the Science Classroom Cooperative Learning Teaching for Conceptual Change Teaching with Gender Balance Questioning Techniques for Science Teachers Environmental Connections in the New Science Programs Agriculture Connections in the New Science Programs	
Price	$25	
Author	Alberta Education	
Distributor	LRDC	0SC10128

Project Wild: Secondary Activity Guide (1985)

Format	Print
Annotation	A collection of interdisciplinary and supplementary environmental education materials emphasizing wildlife conservation. Activities are indexed by topic, grade, subject and skill. (Authorized for EOE.)
Price	Available free on request
Distributor	Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, Conservation Education

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Safety and Organization in School Science Facilities (1990)

Format	Print
Annotation	Guidelines for lab safety, checklists, fire prevention, radiation protection, safety with biological chemicals
Price	Available free on request
Author	Science Education Consultants' Council, Alberta Education
Distributor	Regional Offices of Education - Science Consultants

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Science Process and Discovery - Second Edition (1985)

Format	Print IESN 0-201-18628-4
Annotation	• Examines significant events in the history of science and topics of current research through the use of short case studies. • Written for the general level science student but allows deeper analysis of the scientific method for the more advanced student. • Short narrative articles are followed by two different questions sets. • Analysis provokes thinking about the cycles of proof and scientific principles. • Accompanying Teacher's Guide contains objective questions for each narrative.
Price	Student book $14.25 U.S.; Teacher's Guide, Price not available
Author	Dennis Field
Distributor	Addison-Wesley Publishers Limited

Science 10 Item Bank
(Science 20, Biology 20, Chemistry 20 and Physics 20 item banks are under development)

Format	Currently only available in the Macintosh format (or hard copy from LRDC)
Annotation	This is a collection of test items created "by teachers for teachers." The items have been submitted by Science 10 field validation teachers, Alberta Education Program Consultants and Student Evaluation Branch Test Development Specialists. The items have been entered into LXR TESTS and edited by Alberta Distance Learning Centre personnel. The item bank is constantly under revision so teachers should arrange for periodic updates. To acquire the itembank, simply send a disk(s) to ADLC requesting the most recent version and the disk will be returned to you. **Note:** You must have LXR TEST software to access the item bank questions on disk.
Price	Available free on request
Distributor	Alberta Distance Learning Centre

Senior High English Teacher Resource Manual (1991)

Format	Print
Annotation	This TRM offers additional teaching strategies (e.g., developing writing, listening and speaking skills) related to language arts learning but which may also be useful in senior high science classes.
Price	$14.10
Author	Alberta Education, Curriculum Branch
Distributor	LRDC 0XS10025

STS Science Education: Unifying the Goals of Science (1990)

Format	Print
Annotation	Provides a comprehensive description that will help teachers integrate the STS concept into their teaching schemes
Price	$3.05
Author	Alberta Education, Curriculum Support
Distributor	LRDC 0XS10017

Teaching Thinking: Enhancing Learning (1990)

Format	Print
Annotation	Principles and guidelines for cultivating thinking, ECS to Grade 12, have been developed in this resource. It offers a definition of thinking, and describes nine basic principles on which the suggested practices are based, and discusses possible procedures for implementation in schools and classrooms.
Price	$4.25
Author	Alberta Education, Curriculum Branch
Distributor	LRDC 0XS00125

Together We Learn (Cooperative and Small-Group Learning) (1990)

Format	Print/Video
Annotation	Together We Learn has been designed as a practical "how-to" handbook to help teachers implement small group learning strategies in their classrooms. The book offers the following to teachers: • A nuts-and-bolts approach to cooperative learning that provides student classroom suggestions and aids. • Thorough coverage of cooperative learning approaches to assist teachers of varying levels of experience with group work. • Suggestions that are relevant to all grades, disciplines and students. • A jargon-free easy-to-read treatment of cooperative learning techniques. Video available from ACCESS.
Price	$30.75
Author	R. Wideman et al.
Distributor	LRDC 0SS07073

OTHER LEARNING RESOURCES

Unit 1

Atlas of Environmental Issues (1989)

Format	Print	ISBN 0-8160-2023-X
Annotation	Describes and explains major environmental issues of today's world including soil erosion, deforestation, mechanized agriculture, oil pollution of oceans, acid rain, overfishing, and nuclear power. Excellent graphics. (Listed as support for EOE.)	
Price	$16.95 U.S.	
Author	Nick Middleton	
Distributor	Facts on File	

Atmosphere: World of Chemistry Series

Format	Video (15 min.)
Annotation*	Beginning with a common theory on the formation of the atmosphere, this program moves into today's composition and highlights some of our environmental concerns about the contaminants being added to the atmosphere. The greenhouse effect, the hole in the ozone layer, and the commercial use of CFC's are highlighted.
Price	$55 ($450 for series)
Distributor	Magic Lantern Communications Ltd.

The Biology of Water: Science Screen Report Series

Format	Video (15 min.)
Annotation*	A study of one of our most precious resources . . . water. Discover how much we rely on this life-giving liquid. Learn about its role in photosynthesis and find out the difference between osmosis and diffusion.
Price	$99
Distributor	Magic Lantern Communications Ltd.

Blue Planet, Physical/Chemical Makeup: Planet Earth Series (1986)

Format	Video (29 min.)
Annotation	The program explains how large bodies of water have a moderating effect on the climate of surrounding areas. It also introduces the use of satellites to explain and predict weather patterns and water temperature.
Price	See ACCESS catalogue
Distributor	ACCESS VC313403

The Blue Revolution: The Return of the Child: The Effects of "El Niño"

Format	Video (26 min.)
Annotation	This program charts the birth and development of the weather system called "El Niño," so-called because it is born at the time Christmas is celebrated. The most severe El Niño on record was first noticed in 1982: in Peru, the fishing waters were 15 degrees above normal, and the catch small; Australia had its worst drought in a century, the continent became a giant dustbowl, mini-tornadoes sucked away the topsoil, and in February of 1983 a giant dust storm darkened Melbourne; drought hit India, and heavy seas and high tides pounded the Western U.S.; hurricanes battered Polynesia. This program shows the ferocity of El Niño, relates it to the ocean waters, and traces the roots of man's study of waves, ocean currents, and the interaction of sea and sky.
Price	$149 U.S.
Distributor	Films for the Humanities and Sciences

Conservation Strategy (1988)

Format	Print (pamphlets)
Annotation	Includes a series of discussion papers: • Tourism in Alberta • Agricultural Considerations for Today and Tomorrow • Healthy Planet, Healthy People • Oil and Gas in Alberta: An Uncertain Future • Foundations for the Future: Alberta's Mineral Resources • Energy Conservation: A Goal for Albertans • Renewable Energy: The Power and the Potential • Environment by Design • Reserves for Nature • A Place for Wildlife • Environmental Education for a Sustainable Future • Dinosaurs and Distant Drums • Perspectives for an Alberta Conservation Strategy • Resolving Conflict: A Case Study • Alberta Conservation Strategy: Strategic Framework in Action

- Alberta Conservation Strategy: Strategic Framework in Brief
- Alberta Wetlands: Water in the Back
- Our Dynamic Forests: The Challenge of Management
- People, Parks and Preservation
- Electricity: Development for a Sustainable Future
- Saving the Strands of Life: Alberta's Biodiversity

Price: Available free on request

Author: Alberta Conservation Strategy Project

Distributor: Environment Council of Alberta

Disappearing Forests: Spaceship Earth Series

Format: Video (28 min.)

Annotation*: "The world was covered with forests long before man began to clear them. Natural forests have been at the mercy of nature since the beginning of time. They have been wiped out by ice ages, natural storms, hurricanes, fire and floods. Satellite images around the world show forest fires and forest clearance." The program discusses the real extent of this and the impact on Earth and on the people who live in these regions. Man has long cleared forests for dwellings, firewood and farming. Human needs in each area must be weighed up against the needs of the planet and its survival. Locations include the Amazon rainforest, Brazil, and Hubbard Brook, U.S.A., as well as Bolivia, China, Australia and England. This program is well suited to teaching the STS connections involving "Global Deforestation."

Price: $350

Distributor: Le Groupe Multimédia du Canada

Energy: Science Show Series

Format: Video

Annotation*: Is there anything in common between a runner's energy and the energy used to light and warm us? The Science Show tells us that yes, there is, and explains that, just like machines, living things consume energy. In nature, the energy of the Sun is what nourishes plants, animals and human beings. However, man has learnt to harness other forms of energy, such as electricity which was largely responsible for the development of our industrial societies. Scientists are also striving to master new energy forms. Hydrogen, available in unlimited quantities in water, is one of the resources of the future.

Price: $250

Distributor: Le Groupe Multimédia du Canada

Energy Flow in the Biosphere: Energy Flow Series (1984)

Format	Video (10 min.)
Annotation*	The burning of fossil fuels has led to a global increase of carbon dioxide in the atmosphere. James Moriarty discusses the repercussions – the greenhouse effect. (Uses some computer animation.)
Price	See ACCESS catalogue
Distributor	ACCESS VC324306

Exploring the Atmosphere: Meteorology in Canada (1989)

Format	Videocassette (28 min.)
Annotation*	The study and forecasting of weather is important to Canadians, even though it has always been an imperfect science. Farmers and pilots are especially dependent on accurate information, but all of us rely on the weather forecasts to plan our day. With the advent of satellites, computers and better communications, meteorologists are improving their forecasting skills.
Price	See ACCESS catalogue
Distributor	ACCESS VC339301

Global Warming: Climate and Man Series

Format	Video (26 min.)
Annotation	The history of Earth has been a history of temperature change; historically, people and animals have moved to better climes, richer pastures, more abundant food. The problem now is that "somewhere else" is already occupied; meanwhile, temperatures appear to be rising, with foreseeably disastrous consequences. The gases in the air which cause the greenhouse effect have made life possible; too many gases, however, and catastrophe looms. Observation, historical records, and computer models lead to the conclusion that temperatures are rising, though no one can be certain how high they will go, or when, or what will happen. Low-lying areas will be under water, of course, as ice melts and sea levels rise; diseases and predators will proliferate; rains will increase in some parts of the world, while drought strikes elsewhere and mass starvation results. This program is helpful in addressing STS connections.
Price	$149 U.S.
Distributor	Films for the Humanities and Sciences

Learning Weather: A Resource Study Kit (1989)

Format	Kit	ISBN 0-66-013354-7
Annotation	Resource Study kit contains: 1. Mapping Weather 2. Knowing Weather 3. Knowing Clouds	
Price	$5.95	
Distributor	Canadian Government Publishing Centre	

Light and Energy: Science Show Series

Format	Video (22:30 min.)
Annotation*	What is the principle source of energy on this planet? Would you believe, photosynthesis! As a matter of fact, by using this chemical reaction, plants capture the light of the Sun and transform it into energy – rich chemical compounds. On this planet, the energy stored by plants every year represents ten times mankind's consumption and corresponds to two hundred times mankind's food requirements! It is no wonder that researchers are trying to harness the energy stored by plants. This program describes such attempts, as well as sophisticated techniques enabling researchers to measure plant photosynthesis. In closing, the host describes the current state of solar energy research. Several different methods, such as simple solar captors or photovoltaic cells, are already available to us to capture the Sun's energy and convert it to a usable form.
Price	$250
Distributor	Le Groupe Multimédia du Canada

The National Geographic Atlas of the World, 5th Edition (1981)

Format	Print	ISBN 0-87044-347-X
Annotation	Several of the maps at the beginning of the atlas emphasize the earth as large interconnected system. In particular, the map on page 18 gives a global picture of solar-driven weather systems.	
Price	$44.95 U.S.	
Distributor	National Geographic Society, Educational Services	

Photosynthesis: Energy Flow Series (1984)

Format	Video (10 min.)
Annotation*	A demonstration of how chlorophyll in plants absorbs and transfers captured light to other molecules to eventually create "energy storage molecules," such as glucose. (Uses computer animation.)
Price	See ACCESS catalogue
Distributor	ACCESS VC324302

Seeing the Light – Photosynthesis Series

Format	Video (10 min.)
Annotation*	An introduction to the process of photosynthesis, through the historical discoveries of Joseph Priestly, Jan Ingenhousz, and Jean Senebier. The classic equation is developed step-by-step, with reference to the role played by each of the ingredients from raw materials to the finished product.
Price	See ACCESS catalogue
Distributor	ACCESS VC324501

The Swirling Seas: Spaceship Earth Series

Format	Video (23 min.)
Annotation*	The ocean is a thermostat for Spaceship Earth, and home for many creatures. Life began in the sea. Water covers nearly three quarters of the Earth's surface. Satellites transformed the human view of the world's oceans and coastal seas. Maps which took centuries of sea-going observations to compile were surpassed by the constant stream of data from space. It is hopeful that views from space can help human beings understand the oceans better. The temptation to overfish grows stronger as technology improves. Exactly how the seas influence and serve the life support system of Spaceship Earth is discussed in this program. Also fits Unit 3.
Price	$350
Distributor	Le Groupe Multimédia du Canada

Sun, Sunlight and Weather Patterns: Climate and Man Series

Format	Video (26 min.)
Annotation*	Climate is a changing phenomenon, the first signs of alteration appearing in its day-to-day behaviour – i.e., the weather. Among the readily observable recent changes: an increase in the number and ferocity of giant weather events like hurricanes. The program explains the origin of tropical storms, of tropical rain forests and polar deserts; it shows the route and the effect of the Gulf Stream and its role in the Little Ice Age of the 16th century; theorizes about the events that caused the Sahara to become desert; and examines the link between these events, changes in the sun's activity, and the cycles involving dust storms and volcanic eruption.
Price	$149 U.S.
Distributor	Films for the Humanities and Sciences

Toward a Common Future: A Report on Sustainable Development and Its Implications for Canada (1989)

Format	Print
Annotation	Provides information related to sustainable development. Discusses major issues such as atmosphere, land, water, chemicals, wastes and garbage, and implications for government, business, industry, public interest groups, education and individuals.
Price	Not available
Author	Michael Keating
Distributor	Environment Canada

Understanding Our Environment (1991)

Format	Print ISBN 0-19-540770-9
Annotation	This textbook is designed for senior high school students, as it focuses on global environmental issues. The text is divided into three units: Ecosystems and the Earth's Environment, The Environment, and Management and Conservation. The book also contains current data in the form of graphs and tables as well as photographs to assist students in achieving a clear understanding of concepts. Knowledge and application-type questions are given at the end of each chapter for evaluation purposes. Fits all units in Science 10.
Price	$30
Author	Stewart Dunlop and Michael Jackson
Distributor	Oxford University Press

Understanding Weather and Climate

Format	Video (50 min.)
Annotation*	This two-part program is designed to help students learn about and understand the scientific principles that determine weather conditions. Part 1 describes the different elements that combine to create the variety of weather conditions that exist on Earth. The second part deals with local weather which changes daily as well as slower changes which may be happening to our climate. Students discover some of the causes of these changes.
Price	$285
Distributor	T.H.A. Media Distributors

Water: World of Chemistry Series

Format	Videc (15 min.)
Annotation*	Water has unusual properties that are explained through an exploration of the molecular model. This program provides a graphic view of water's properties, as well as real-world examples such as making artificial snow, the development of water-soluble polymers and the purification of drinking water.
Price	$55 ($450 for series)
Distributor	Magic Lantern Communications Ltd.

Water: A Fascinating Liquid (1991)

Format	Video (13 min.)
Annotation*	Absolutely no life form can exist without water. This video examines the chemical composition of this amazing substance, using experiments to isolate and observe its unique characteristics.
Price	$315
Distributor	Marlin Motion Pictures Ltd.

The Weather Companion – An Album of Meteorological History, Science, Legend and Folklore (1988)

Format	Print	ISBN 0-471-62079-3
Annotation	Contains chapters on "Weather Past," "Weather tools," "Weather Phenomenon," "Storm Warnings," "Weather and Wildlife," "Botanical Weather," "The Weather, You, and Me."	
Price	$12.95 U.S.	
Author	Gary Lockhart	
Distributor	John Wiley and Sons, Inc.	

Alternatives to Pesticides

Format	Print (factsheet)
Annotation	Discusses alternative methods of pest control for trees and shrubs, lawns and vegetables gardens. Also offers suggestions for companion planting.
Price	Available free on request
Distributor	Environment Canada (Edmonton)

The Cell and Energy: Cellular Respiration Series (1988)

Format	Video (10 min.)
Annotation*	The cell's energy molecule, glucose, is examined and the process of extracting energy from glucose and transferring it to ATP in specific organelles called mitochondria is discussed. The structure, function and evolution of these organelles are illustrated in relation to their role in cellular respiration.
Price	See ACCESS catalogue
Distributor	ACCESS VC324201

The Cytoplasm: Cell Biology Series

Forma	Video (14 min.)
Annotation*	This program defines the cytoplasm and looks through the electron microscope at organelles. The function of organelles is described as well as the nature of protein synthesis. The dynamics of photosynthesis and aerobic respiration are discussed.
Price	$325
Distributor	Coronet Film and Video

Energy Flow at the Cellular Level: Energy Flow Series (1984)

Format	Video (10 min.)
Annotation*	A look at energy flow at the cellular level, where a single cell is likened to a micro-ecosystem. The organelle, the part of the cell chiefly responsible for releasing the stored energy of photosynthesis, is the mitochondrion. (Uses some computer animation.)
Price	See ACCESS catalogue
Distributor	ACCESS VC324302

The Fluid Transport System: Photosynthesis Series (1987)

Format	Video (10 min.)
Annotation*	This program looks at the carbon cycle and illustrates the role that plants play in ensuring the survival of all animal life. Using the California redwood as a model, the intricate dual system of fluid transport is examined.
Price	See ACCESS catalogue
Distributor	ACCESS

Inside the Cell: Microstructures, Mechanisms and Molecules

Format	Filmstrips on Video (44 min/4 parts)
Annotation*	Designed to show students cell organization as it appears through photo- and electron-microscopy. Micrographs are supplemented with detailed drawings and diagrams to present a thorough introduction to cell structure and function. Introduces the specific structures and functions of each kind of organelle - cilia and flagella, the nucleus and ribosomes and their role; endoplasmic reticulum; the Golgi apparatus; lysosomes; mitochondria and that special organelle unique to green plants, chloroplast.
Price	$285
Distributor	McIntyre Media Limited

Lawn Herbicides

Format	Print (factsheet)
Annotation	Describes how lawn herbicides work, their uses, restriction on use, environmental hazards, health hazards (abnormal cell growth) and safety precautions.
Price	Available free on request
Distributor	Environment Canada (Edmonton)

Microscope: An Indispensable Instrument

Format	Video
Annotation*	Flawed and imperfect as they were, microscopes altered our perceptions of the world from the very beginning. As the science of microscopy grew, so did our understanding of the inner workings of life. Soon people saw cells dividing, understood that germs caused disease, and medicine took a giant leap forward. In this videocassette, we will focus on the progression of the microscope, a tool that has opened new vistas in the world of science and technology.
Price	$99
Distributor	Magic Lantern Communications Ltd.

The Microscope and Its Incredible World

Format	Video (21 min.)
Annotation*	This program shows photomicrography with several specimens, demonstrating the range of the microscope. It also presents step-by-step techniques for using and maintaining a microscope and specimen slides. For classrooms without a supply of specimen slides, the video suggests several easily acquired substances for viewing under a microscope, such as pond water and salt crystals. The video presents a brief description of the microscope's history and points out that medical research, including cancer research, depends heavily on the lens and electron microscopes.
Price	See ACCESS catalogue
Distributor	ACCESS VC305101

Osmoregulation: Homeostasis Series

Format	Video
Annotation*	An exploration of the process of osmoregulation, using as an example the complex filtering process that takes place in the kidneys.
Price	See ACCESS catalogue
Distributor	ACCESS VC324403

Pesticide Education Program

Format	Kit (5 Parts)
Annotation	This resource consists of 5 parts: 1. Forest Tent Caterpillar Study 2. Mosquito Kit 3. Vegetative Management Study 4. Pesticide Education Unit 5. Weed Kit Each of the kits fit into the Junior or Senior science curricula. Kits 4 and 5 have the best fit with Science 10.
Price	Available free on request
Distributor	Alberta Environment, Education Branch

The Plasma Membrane: Cell Biology Series

Format	Video (14:30 min.)
Annotation*	This program outlines the following concepts: 1) How materials diffuse across a cell membrane in terms of concentration gradients; 2) How metabolic energy is used to do the work of transporting substances across membranes against their concentration gradients; 3) Describing the processes of endocytosis and exocytosis in cells.
Price	$325
Distributor	Coronet Film and Video

Recognizing Herbicide Action and Injury

Format	Print
Annotation*	Discover how to recognize the symptoms of herbicide-related causes of crop injury. Learn the preventative steps. Understand the way your herbicides work – how they move into plants and where they go once inside the plants. Get to know where they move in the soils and how long they stay there. See what to look for when examining crops for damage and when checking weeds for signs of killing action.
Price	$8
Distributor	Alberta Agriculture

The Sea Within: Homeostasis Series

Format	Video
Annotation*	This program looks at body fluids, which are constantly being adjusted and balanced through the mechanisms of homeostasis to meet internal needs and external conditions. Described are the five basic mechanisms of homeostasis that control the exchange of intracellular and extracellular fluids.
Price	See ACCESS catalogue
Distributor	ACCESS VC324402

Using Dimethoate Safely

Format	Print (factsheet)
Annotation	Dimethoate is a systemic pesticide which kills insects by interfering with the action of enzymes in the nervous system. Includes information on how it works, uses, restrictions on use, environmental hazards, health hazards, and safety precautions.
Price	Available free on request
Distributor	Environment Canada (Edmonton)

Unit 3

Acid Rain: A North American Challenge (1988)

Format	Video (16 min.)
Annotation	Summarizes what we know today about the causes and effects of acid rain, a menacing threat to our environment.
Price	See ACCESS catalogue
Distributor	ACCESS VC315601

Acidic Deposition

Format	Print
Annotation	Includes background information and a series of activities related to acidic deposition. There are six modules in the package: What is Acidic Deposition? Sources of Acidic Deposition? Acid Sensitivity Effects of Acidic Deposition Sustainable Development Solutions
Price	Being developed. Will be available free on request. Fall 1992.
Distributor	Alberta Environment

Alberta Clean Air Act (1985)

Format	Print (pamphlet)
Annotation	Contains conclusions and recommendations of the review of the Clean Air Act – a report to the Minister of the Environment. (Authorized for Junior High Science.)
Price	Available free on request
Distributor	Environment Council of Alberta

Alberta's Special Waste Management System

Format	Print (booklet)
Annotation	Provides information about management of special and hazardous wastes in Alberta. The booklet also provides a list of contacts for further information
Price	Available free on request
Distributor	Alberta Special Waste Management Corporation

Assault on the Ozone Layer: The Fragile Planet Series

Format	Video (18 min.)
Annotation	Industrial smog over the ice fields of Alaska. A growing hole in the ozone layer over Antarctica. CFCs released in Japan spreading across the Pacific in two weeks, across the entire Northern Hemisphere in four, below the Equator in six, to the South Pole in ten. Destruction of the ozone layer affects the entire globe, regardless of who is doing it, where, or why. This program shows how the ozone layer is depleted and how its depletion is stunting, mutating and destroying life. This program is helpful in addressing STS connections.
Price	$149 U.S. ($749 for series)
Distributor	Films for the Humanities and Sciences

Atlas of Environmental Issues (1989)

Format	Print ISBN 0-8160-2023-X
Annotation	Describes and explains major environmental issues of today's world including soil erosion, deforestation, mechanized agriculture, oil pollution of oceans, acid rain, overfishing, and nuclear power. Excellent graphics. (Listed as support for EOE.)
Price	$16.95 U.S.
Author	Nick Middleton
Distributor	Facts on File

Atmosphere: World of Chemistry Series

Format	Video (15 min.)
Annotation*	Beginning with a common theory on the formation of the atmosphere, this program moves into today's composition and highlights some of our environmental concerns about the contaminants being added to the atmosphere. The greenhouse effect, the hole in the ozone layer, and the commercial use of CFCs are highlighted.
Price	$55 ($450 for Series)
Distributor	Magic Lantern Communications Ltd.

Atom: World of Chemistry Series

Format	Video (15 min.)
Annotation*	This program focuses on some of the most abstract ideas in beginning chemistry. Early experiments, such as the cathode ray tube and Rutherford's gold foil experiment and other developments leading to the modern view of the atom are shown. The program ends with graphics of atomic surfaces using the Scanning Tunneling Microscope (STM).
Price	$55 ($450 for series)
Distributor	Magic Lantern Communications Ltd.

Chemical Reactions (1991)

Format	Video (13 min.)
Annotation*	Through several simple experiments, this video shows that chemical reactions involve the conversion of substances and the release or absorption of energy. Viewers learn that these reactions occur continuously, with one important example being plants producing oxygen through photosynthesis.
Price	$315
Distributor	Marlin Motion Pictures

CRC Handbook of Hazardous Laboratory Chemicals: Information and Disposal (1991)

Format	Print ISBN: 084930265X
Annotation	Includes information about physical properties, fire hazard, chemical properties, hazardous reactions, physiological properties and health hazards, spillage disposal, waste disposal, and reactions for spillage and waste disposal.
Price	$95 U.S.
Author	M. A. Armour
Distributor	CRC Press

Decomposition and Synthesis – 2 Sides to Reaction Chemistry: From Theory to Application Series (1989)

Format	Video (10 min.)
Annotation*	The common compound salt – sodium chloride – is decomposed by electrolysis into its two elements, sodium and chloride, in an endothermic reaction that consumes much electrical energy. In the exact opposite of decomposition - synthesis - salt is produced from sodium and chlorine. The result is a violent exothermic reaction – and salt. Recommended use as an extension resource.
Price	$190
Distributor	Marlin Motion Pictures

Destination Conservation

Format	Print
Annotation	Destination Conservation is a program designed for delivery to Alberta school jurisdictions who seek to improve their energy, water and waste management practices. The manual consists of three sections: 1. The Program Begins Initial Awareness Activities Determining Energy and Resource Consumption Levels 2. Taking Action Energy Audit and Action Plan Conservation Campaign Resource Audit and Action Plan 3. Further Awareness and Action A Global Perspective Individuals Can Make a Difference Environmental Connections Overpopulation Energy and the Environment Transportation Global Warming/Greenhouse Effect Ozone Layer Depletion Deforestation Water Conservation Ecological Landscaping and Gardening Waste Management Cost Recovery Program for Paper Hazardous Materials
Price	$35
Distributor	Environmental Resource Centre

Don't Give Hazardous Wastes a Home

Format	Print (factsheet)
Annotation	Describes hazardous wastes to look for in the home, the categories of hazardous wastes and the Toxic Roundup program.
Price	Available free on request
Distributor	Alberta Special Waste Management Corporation

The Earliest Models: Structure of the Atom Series (1985)

Format	Video (10 min.)
Annotation*	Examines the developments in the study of the atom through the ages. Reviews two thousand years of experiments that lead to the modern atom model. Mentions Democritos, Roger Bacon, William Gilbert, Niccolo Cabeo, Benjamin Franklin, Charles Augustin Coulomb, Antoine Lavoiser, and Joseph Provost.
Price	See ACCESS catalogue
Distributor	ACCESS VC301101

Energy Flow in the Biosphere: Energy Flow Series (1984)

Format	Video (10 min.)
Annotation*	The burning of fossil fuels has led to a global increase of carbon dioxide in the atmosphere. James Moriarty discusses the repercussions – the greenhouse effect. (Uses some computer animation.)
Price	See ACCESS catalogue
Distributor	ACCESS VC324306

Envirodial

Format	Print – dial
Annotation	Provides information about alternatives to using hazardous products in the home and hints for household hazards.
Price	Available free on request
Distributor	Alberta Special Waste Management Corporation

Environment: Science Show Series

Format	Video (22:30 min.)
Annotation*	Our planet's SOS cries are becoming increasingly alarming. All forms of pollution are stripping and stifling our planet. The Science Show looks into the global situation and provides keys to better understanding such phenomena as PCBs and acid rain. In the end, breathtaking imagery enables us to visualize the repercussions of the greenhouse effect and the depletion of the ozone layer. This program is a very good resource for discussing STS connections outlined in the curriculum.
Price	$250
Distributor	Le Groupe Multimédia du Canada

Environmental Choice Factsheets

Format	Print (factsheet)
Annotation	Water-Based Paints Reduced Pollution Water-Based Paint Reduced Pollution Solvent-Based Paint Ethanol Blended With Gasoline Zinc-Air Batteries Reusable Shopping Bags Products Made From Recycled Plastic
Price	Available free on request
Distributor	Environmental Choice

Environmental Issues: Waste Management

Format	Print (booklet)
Annotation	Includes information about waste management, control and disposal techniques and regulation.
Price	Available free on request
Distributor	Canadian Petroleum Association

Get the Lead Out: Challenge Journal Series (1990)

Format	Video (23:30 min.)
Annotation*	Are we creating the disabilities of tomorrow? Host Ed Wadley interviews Kathy Cooper, Jennifer Penney and Dr. Barry Zimmerman, and examines the relationship between our planet's environmental crisis and its effects on our health. Profile visits Aine Suttle, whose young son Brendan tested positive for high lead, and how she's now helping to get the lead out of her community.
Price	$150
Distributor	CTV

Global Warming: Climate and Man Series

Format	Video (26 min.)
Annotation*	The history of Earth has been a history of temperature change; historically, people and animals have moved to better climates, richer pastures, more abundant food. The problem now is that "somewhere else" is already occupied; meanwhile, temperatures appear to be rising, with foreseeably disastrous consequences. The gases in the air which cause the greenhouse effect have made life possible; too many gases, however, and catastrophe looms. Observation, historical records, and computer models lead to the conclusion that temperatures are rising, though no one can be certain how high they will go, or when, or what will happen. Low-lying areas will be under water, of course, as ice melts and sea levels rise; diseases and predators will proliferate; rains will increase in some parts of the world, while drought strikes elsewhere and mass starvation results. This program is helpful in addressing STS connections.
Price	$149 U.S.
Distributor	Films for the Humanities and Sciences

The Greenhouse Effect: Climate and Man Series

Format	Video (26 min.)
Annotation*	A life-sustaining envelope of gas surrounds the earth. This atmosphere contains oxygen, CO_2, water vapour, and other gases; this is what generates climate, which affects all living beings. The program analyzes the sun's gradual brightening and the relationship between sunlight and CO_2, explains why the atmosphere of Mars has too much and Venus too little CO_2 to sustain life, theorizes about the disappearance of dinosaurs and dinosaur-friendly climate, and explains the relationship between climatic change and continental drift. This program is helpful in addressing STS connections.
Price	$149 U.S.
Distributor	Films for the Humanities and Sciences

A Guide to WHMIS

Format	Print (booklet)
Annotation	Provides information about WHMIS.
Price	Available free on request
Distributor	Alberta Occupational Health and Safety

Introducing WHMIS

Format	Print (pamphlet)
Annotation	Includes information about: hazardous materials in the workplace, hazard identification and ingredient disclosure, labels and other forms of warning, material safety data sheets, worker education and training, and confidential business information protection.
Price	Available free on request
Distributor	Alberta Occupational Health and Safety

Lab Safety: The Accident at Jefferson High

Format	Video (18 min.)
Annotation*	This program discusses laboratory safety with respect to equipment and chemicals that are usually present in the lab. The video appeals to high school students as it employs the use of drama to gain insight into the many factors involved in lab safety.
Price	See ACCESS catalogue
Distributor	ACCESS VC340501

The Mole: World of Chemistry Series

Format	Video (15 min.)
Annotation*	The Mole; Avogadro's Law, the mole as a unit for counting particles, the size of Avogadro's number, relative atomic mass, the importance of using the mole in chemical reactions, and an example of limiting reactants are illustrated using graphics, demonstrations and real world examples.
Price	$55 (or $450 for series)
Distributor	Magic Lantern Communications Ltd.

Our Throwaway Society

Format	Video
Annotation	Reviews the problem of hazardous waste generation by our throwaway society. Looks at Alberta Special Waste Management System near Swan Hills.
Price	No charge to borrow. Also available from ACCESS catalogue.
Distributor	Alberta Special Waste Management Corporation or ACCESS VC321801

Ozone: Planet Under Pressure Series

Format	Video (20 min.)
Annotation*	The 1980s discovery of a hole in the ozone layer was the beginning of the end for chlorofluorocarbons, once touted as harmless wonder chemicals. The program explains the chemistry of destruction of the ozone layer, caused by the build-up of CFCs in the atmosphere.
Price	Not available
Distributor	TV Ontario

Periodic Table: World of Chemistry Series

Format	Video (15 min.)
Annotation*	Periodic Table The arrangement of the elements into an organized set is shown from the historical perspective of Mendeleev's predictions through the changes in the table instituted by Nobel Laureate Glenn Seaborg, who explains his views. Periodicity is extensively illustrated through properties of elements within groups and periods. An unusual feature is a sequence showing how the periodic table is used in making glass (a visit to Corning Glass Company).
Price	$55 (or $450 for series)
Distributor	Magic Lantern Communications Ltd.

Reactions and Their Driving Forces (1988)

Format	Video (15 min.)
Annotation*	A panoply of chemical reactions is shown while asking the question, "What are the driving forces of these reactions?" The first driving force, energy is explained by showing a number of exothermic and endothermic processes in the real world, graphics and demonstrations. The other driving force, entropy, is similarly illustrated.
Price	$55 ($450 for series)
Distributor	Magic Lantern Communications Ltd.

Somebody Should Do Something About This (1992)

Format	Print
Annotation	This resource is designed as a teacher's resource book on energy and the environment. It will provide teachers with background information on non-renewable energy sources, renewable energy sources, energy conservation and energy efficiency, and the environmental effects related to energy use and production. It is divided into sections for easy use: activities, factsheets, additional resources, and an index with an alphabetical listing of energy and environmental terms.
Price	Available free on request
Distributor	Alberta Energy

The Swirling Seas: Spaceship Earth Series

Format	Video (28 min.)
Annotation*	The ocean is a thermostat for Spaceship Earth, and home for many creatures. Life began in the sea. Water covers nearly three-quarters of the Earth's surface. Satellites transformed the human view of the world's oceans and coastal seas. Maps which took centuries of sea-going observations to compile were surpassed by the constant stream of data from space. It is hopeful that views from space can help human beings understand the oceans better. The temptation to overfish grows stronger as technology improves. Exactly how the seas influence and serve the life support system of Spaceship Earth is discussed in this program. Also fits Unit 3.
Price	$350
Distributor	Le Groupe Multimédia du Canada

Toxic Waste: Perspectives in Science Series

Format	Video
Annotation	Opens with a drama about a toxic waste site. Teaches about organic chemistry, biomagnification of the food chain, chemicals, the invention of custom-tailored plastics, and the scientific community's responsibility toward educating the public. Describes the role of the government, industry and the public in controlling hazardous waste.
Price	See ACCESS catalogue
Distributor	ACCESS VC321902

Understanding Our Environment (1991)

Format	Print	ISBN 0-19-540770-9
Annotation	This textbook is designed for senior high school students as it focuses on global environmental issues. The text is divided into three units: Ecosystems and the Earth's Environment, The Environment, and Management and Conservation. The book also contains current data in the form of graphs and tables as well as photographs to assist students in achieving a clear understanding of concepts. Knowledge and application-type questions are given at the end of each chapter for evaluation purposes. Fits all units in Science 10.	
Price	$30	
Author	Stewart Dunlop and Michael Jackson	
Distributor	Oxford University Press	

WHMIS: When You See These Symbols/WHMIS: Hazard Symbols

Format	Posters
Price	Available free on request
Distributor	Alberta Occupational Health and Safety

WHMIS: Working For You

Format	Video
Annotation	Introduces the viewer to the basic concepts of WHMIS.
Price	$20
Distributor	Alberta Association of Safety Personnel/Canadian Society of Safety Engineers

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Unit 4

Alberta Wildflowers: Teachers Resource Kit (1989)

Format	Print
Annotation	This resource was developed in salute to Environment Week '88. The resource kit offers complimentary Alberta Wildflower seed packages (hence the name of the resource) and includes factsheets on topics such as how electricity is produced, coal in Alberta, history of coal in Canada, world coal resources, surface mining and more.
Price	Available free on request
Distributor	TransAlta Utilities

Back to the Sun: Senior High Science Video Series

Format	Video
Annotation	This program examines the conversions of energy from one form to another, with a focus on renewable energy sources. This program supports Science 10 and the current Biology 20.
Price	See ACCESS catalogue; BPN 302208
Distributor	ACCESS

Coal to Kilowatts

Format	Print (brochure)
Annotation	Brief description of electricity generation from coal to customers in 9 steps.
Price	Available free on request
Distributor	TransAlta Utilities

Concept of Energy Flow: Energy Flow Series (1984)

Format	Video (10 min.)
Annotation*	Narrator James Moriarty utilizes the Second Law of Thermodynamics to explore the concept of "entropy," using for study purposes a closed system – represented by the disabled space shuttle. (Uses computer animation.)
Price	See ACCESS catalogue
Distributor	ACCESS VC324301

Conservation of Energy: Mechanical Universe Series (1985)

Format	Video (28.38 min.)
Annotation*	The myth of the energy crisis. According to one of the major laws of physics, energy is neither created nor destroyed.
Price	See ACCESS catalogue
Distributor	ACCESS VC291413

Current Living Series

Format	Print (factsheets)
Annotation	Includes factsheets on topics such as:

Compact Fluorescents in Your Home	Electric Yard and Garden Tools
Electric Ranges	Extension Cords
Electric Frying Pan Buying Guide	Food Dehydrators
Electric Deep Fat Fryers	Food Processors
Power Interruptions	Freezers
Don't Blame the Appliance	Hot Tubs and Spas
Dishwashers	Indoor Electric Barbeques and Grills
Cordless Power Tools	Kitchen Lighting
Convection Ovens	Kitchen Machines
Coffee Machines	Landscape Lighting
Clothes Washers	Lifesaver Outlets
Clothes Dryers	Microwave Jams and Jellies
Christmas Lighting	Microwave Ovens
Central Vacuum Systems	Outdoor Lighting for Security
Bread Maker Buying Guide	Popcorn Makers
Blenders	Portable Electric Heaters
Blanching Vegetables in Your Microwave	Portable Toaster/Broiler Ovens
Bathroom Lighting	Refrigerators
Artificial Lighting for House Plants	Summer Cooking
Appliance Operating Costs	Timers: Savings and Security
	Whirlpools and Masseur Baths

Price	Available free on request
Distributor	TransAlta Utilities

Energy: Science Show Series

Format	Video
Annotation*	Is there anything in common between a runner's energy and the energy used to light and warm us? The Science Show tells us that yes, there is, and explains that just like machines, living things consume energy. In nature, the energy of the Sun is what nourishes plants, animals and human beings. However, man has learnt to harness other forms of energy, such as electricity which was largely responsible for the development of our industrial societies. Scientists are also striving to master new energy forms. Hydrogen, available in unlimited quantities in water, is one of the resources of the future.
Price	$250
Distributor	Le Groupe Multimédia du Canada

Energy and Heat Loss: Science in Focus Series

Format	Video (20 min.)
Annotation*	This program illustrates by use of examples that energy exists in a variety of forms and has the capacity to do work. It defines kinetic energy as energy that is due to motion. The program briefly discusses energy conversions and differences in efficiencies.
Price	$320
Distributor	T.H.A. Media Distribution

Energy From the Sun

Format	Video
Annotation*	Solar energy may be one answer to the concerns of today's energy conscious world. This film takes a fascinating look at the various ways modern technology is used to capture and store the Sun's energy – as an alternative to fossil fuel, and as the key to developing domestic energy sources for the future.
Price	$420
Distributor	Britannica Learning Materials

Energy Transfer: Science In Focus Series

Format	Video (20 min.)
Annotation	This program discusses the definitions of potential and kinetic energy using various examples. It also describes many different types of energy transfers in real-life situations.
Price	$320
Distributor	T.H.A. Media Distribution

Keephills: Moving for Progress

Format	Print (factsheets)
Annotation	Factsheet on Keephills.
Price	Available free on request
Distributor	TransAlta Utilities

Light and Energy: Science Show Series

Format	Video (22:30 min.)
Annotation*	What is the principle source of energy on this planet? Would you believe, photosynthesis! As a matter of fact, by using this chemical reaction, plants capture the light of the Sun and transform it into energy – rich chemical compounds. On this planet, the energy stored by plants every year represents ten times mankind's consumption and corresponds to two hundred times mankind's food requirements! It is no wonder that researchers are trying to harness the energy stored by plants. This program describes such attempts, as well as sophisticated techniques enabling researchers to measure plant photosynthesis. In closing, the host describes the current state of solar energy research. Several different methods, such as simple solar captors or photovoltaic cells, are already available to us to capture the Sun's energy and convert it to a usable form.
Price	$250
Distributor	Le Groupe Multimédia du Canada

Mining

Format	Print (booklet)
Annotation	Factsheet on coal mining
Price	Available free on request
Distributor	TransAlta Utilities

More Power to You

Format	Print (booklet)
Annotation	105 energy-wise tips from Albertans.
Price	Available free on request
Distributor	TransAlta Utilities

Potential Energy and Kinetic Energy

Format	Video (10 min.)
Annotation*	An introduction to mechanical energy, the relationship between potential energy and kinetic energy, and the meaning of the Law of Conservation and Energy.
Price	$69.95 U.S.
Distributor	Films for the Humanities and Sciences

Potential Energy: Mechanical Universe Series (1985)

Format	Video (28:38 min.)
Annotation	The nature of stability. Potential energy provides a clue, and a powerful model, for understanding why the world has worked the same way since the beginning of time.
Price	See ACCESS catalogue
Distributor	ACCESS VC291414

Reclamation

Format	Print (factsheets)
Annotation	Factsheet on reclamation.
Price	Available free on request
Distributor	TransAlta Utilities

SEEDS: Energy Literacy Series (1983)

Format	Print
Annotation	Useful as a reference for energy activities for students. Student and teacher materials are available. The series consists of several components: 1. Renewable Sources of Energy 2. Energy Technologies 3. Energy in the Future 4. Energy Systems 5. Sources of Electrical Energy 6. Nonrenewable Sources of Energy
Price	Additional copies of the Teacher's Guide can be purchased for $10. Student Books are no longer available but copyright permission is released with purchase of the Teacher's Guide.
Distributor	SEEDS

The Shocking Truth

Format	Print (booklet)
Annotation	Includes information re: What is electricity? Why would we want to change one power source to another? Also details safety tips.
Price	Available free on request
Distributor	TransAlta Utilities

Some Facts (1990)

Format	Print (booklet)
Annotation	Includes information about the net generating capability of hydroplants and coal-fired plants, operations, energy sales, financial information, rates information, environmental policy statements, provincial regulations, making electricity and a glossary of industry terms.
Price	Available free on request
Distributor	TransAlta Utilities

Somebody Should Do Something About This (1992)

Format	Print
Annotation	This resource is designed as a teacher's resource book on energy and the environment. It will provide teachers with background information on non-renewable energy sources, renewable energy sources, energy conservation and energy efficiency, and the environmental effects related to energy use and production. It is divided into sections for easy use: activities, factsheets, additional resources, and an index with an alphabetical listing of energy and environmental terms.
Price	Available free on request
Distributor	Alberta Energy

Sundance Generating Plant

Format	Print (factsheets)
Annotation	Factsheet on generating plants.
Price	Available free on request
Distributor	TransAlta Utilities

Tour TransAlta

Format	Print (brochure)
Annotation	Describes free guided tours of TransAlta's generating plants and mining operations.
Price	Available free on request
Distributor	TransAlta Utilities

Wabamun Generating Plant

Format	Print (factsheets)
Annotation	Factsheet on generating plant.
Price	Available free on request
Distributor	TransAlta Utilities

Water Power

Format	Print (booklet)
Annotation	Discusses hydro-electric power in Alberta. Particularly the Bow River Electric System, the spray system, how electricity is produced, and the North Saskatchewan River system.
Price	Available free on request
Distributor	TransAlta Utilities

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