Saskatchewan
Learning

# Energy and Mines 10, 20, 30 Curriculum Guide

## A Practical and Applied Art

Saskatchewan Learning
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# Introduction

Within Core Curriculum, the Practical and Applied Arts (PAA) is a major area of study that incorporates five traditional areas of Home Economics Education, Business Education, Work Experience Education, Computer Education and Industrial Arts Education. Saskatchewan Learning, its educational partners and other stakeholders have collaborated to complete the PAA curriculum renewal. Some PAA curriculum guidelines have been updated; some components have been integrated, adapted or deleted; some Locally Developed Courses have been elevated to provincial status; and some new guidelines have been developed.

A companion Practical and Applied Arts Handbook provides background on Core Curriculum philosophy, perspectives and initiatives. The Handbook articulates a renewed set of goals for PAA. It presents additional information about the PAA area of study, including guidelines about Work Study and related Transition-to-Work dimensions. In addition, a PAA Information Bulletin provides direction for administrators and others regarding the implementation of PAA courses. Lists of recommended resources for all PAA guides will be compiled into a PAA Bibliography with periodic updates.

# Philosophy and Rationale

The products of the energy and mining industries are vital to human survival. It is essential that students working in this curriculum understand the interconnections among human needs and wants, renewable and nonrenewable resources, human economic activity and the global environment.

The Energy and Mines Curriculum provides a comprehensive view of energy and mineral development in Saskatchewan and in Western Canada. It encompasses an understanding of the geological foundations of mineral resources, the physical and geographic foundations of energy resources and the technological and economic nature of resource exploration, development, marketing and management.

The theme of responsible management, with parallel goals of sustainable development and environmental conservation, underlies the entire program. Students will develop the knowledge, skills and attitudes to appreciate the nature of resource development within the parameters of economic, social and environmental responsibility.

Students will be encouraged to apply and further develop the knowledge and skills acquired in other levels and programs in the Core Curriculum. The focus in the Energy and Mines Curriculum, as in other areas of the Practical and Applied Arts, will be on concrete and physical application of skills and principles.

# Aim, Goals and Foundational Objectives

## Aim

The aim of the Energy and Mines 10, 20, 30 is to provide students with information, skills and abilities that will both make them knowledgeable and responsible citizens and prepare them to pursue careers or employment opportunities in energy and mining industries and/or the services supporting them.

## Goals

***Awareness***: To provide students with an awareness of the nature, technology and products of Saskatchewan's energy and mining industries, as well as the related goods, services and processes that support those industries.

***Environmental Stewardship***: To foster positive attitudes toward and creative problem solving about, responsible resource management and environmental sustainability.

***Connections between School, Work and Community***: To create a connection for students between the world of school and the world of work and to use relevant community examples and sources wherever possible.

***Business and Entrepreneurship***: To develop the skills and abilities that encourage and enable students to pursue opportunities in energy and mining industries via post-secondary education, apprenticeship programs, entrepreneurship, or direct employment.

***Employability Skills***: To develop job and safety skills appropriate to direct employment in the energy and mining industries, through classroom activity, job shadowing, work experience and work study components.

## Foundational Objectives

Foundational objectives are the major, general statements that guide what each student is expected to achieve for the modules of the PAA curriculum. Foundational objectives indicate the most important knowledge, skills, attitudes/values and abilities for a student to learn in a subject. Both the Foundational Objectives for Energy and Mines 10, 20, 30 and the Common Essential Learnings (CELs) Foundational Objectives to be emphasized are stated in this document. Some of these statements may be repeated or enhanced in different modules for emphasis. The Foundational Objectives of the Energy and Mines 10, 20, 30 curriculum are as follows:

- To demonstrate knowledge of the diversity and the economic, social and environmental significance, of Saskatchewan energy and mining industries.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To foster an attitude of environmental responsibility.
- To become familiar with the technology of the energy and mining industries.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.
- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.
- To demonstrate knowledge of Saskatchewan's landforms and natural environments and their relation to renewable and nonrenewable resources.
- To demonstrate knowledge of the natural processes underlying the formation of mineral, coal and hydrocarbon deposits.
- To understand the geological and geophysical principles underlying the process of resource exploration.
- To become familiar with the history of Saskatchewan's resource industries.
- To become familiar with the legalities of resource exploration and production.
- To become familiar with the nature and components of Saskatchewan's underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.
- To examine the impact of industries involved in resource exploration, production, transport and processing.
- To understand some of the scientific principles that underlie Saskatchewan's energy and resource industries.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.
- To examine and assess the impact of conventional and alternative energy generation and energy conservation technologies in Saskatchewan.
- To demonstrate knowledge of alternative energy resources that are, or could be, used in Saskatchewan.
- To assess the need for and economic impact of, alternative energy resources in Saskatchewan.

## Common Essential Learnings (CELs)

The incorporation of the Common Essential Learnings (CELs) into the instruction and assessment of the PAA curriculum offers many opportunities to develop students knowledge, skills and abilities. The purpose of the CELs is to assist students with learning concepts, skills and attitudes necessary to make transitions to career, work and adult life.

The CELs establish a link between the transition-to-work dimensions and PAA curriculum content. The transition-to-work dimensions included in the PAA curricula are: apprenticeship, career exploration/development, community project(s), employability skills, entrepreneurial skills, occupational skills, personal accountability, processing of information, teamwork and work study/experience. Throughout the PAA curricula, the CELs objectives are stated explicitly at the beginning of each module and are coded in this document, as follows:

| | | |
|---|---|---|
| COM | = | Communication |
| NUM | = | Numeracy |
| CCT | = | Critical and Creative Thinking |
| TL | = | Technological Literacy |
| PSVS | = | Personal and Social Values and Skills |
| IL | = | Independent Learning |

Selected learning objectives for the CELs are included throughout the modules. It is anticipated that teachers will find additional ways to incorporate the CELs into their classroom instruction.

# Course Components and Considerations

Each level of Energy and Mines 10, 20, 30 is a credit program within the area of Practical and Applied Arts and requires 100 hours of instruction. The programs, combining compulsory core modules with a variety of optional modules, have been developed to provide a balance between:
- knowledge and skill development through relevant information and practical application of concepts
- exposure to individuals, businesses and industries involved in the energy and mining sector
- opportunities for mentoring, job shadowing, or work study using community resources

Availability of three credits provides flexibility for the teacher to create one, two, or three courses tailored to local needs. To support this flexibility, a number of characteristics are emphasized throughout the program:
- use of Saskatchewan examples, incorporating wherever possible involvement with community industries, human resources and related support services to provide direct experience with the concepts presented in the course
- designation of most modules as optional with a minimal number of prerequisites for modules.
- integration of career exploration within each focus area
- application of personal safety skills and environmental responsibility in the classroom and the workplace.

In addition to fostering information-based environmental responsibility and providing job and workplace-related skills and knowledge, the course will provide desirable background for entry into the work force or related programs at public and vocational colleges, technical institutes and universities.

## Other Curricular References

Students will already have varying degrees of familiarity with Saskatchewan's energy and mineral resources from other courses and levels in the curriculum. These include, among others, the following:

- Grade 4 Social Studies, Unit 1, Module 1 (Saskatchewan the Province)
- Grade 7 Social Studies, Unit 1 (Location) and Unit 2 (Resources and Land), especially handouts 4, 5, 6
- Grade 7 Science, Unit 2 (Saskatchewan - The Land) and Unit 6 (Renewable Resources in Saskatchewan)
- Grade 8 Science, Unit 3 (The Moving Crust) and Unit 5 (Energy Resources in Saskatchewan)

- Grade 9 Science, Unit 1 (Saskatchewan - The Environment)
- Science 10, Unit A-1 (Water Quality), A-2 (Greenhouse Gases), A-3 (Uranium), B-2 (Energy Management)
- History 20, Unit 5 (Global Issues)
- Social Studies 20, Unit 3 (Environment)
- Biology 20, Unit 4 (Agricultural Ecology of Saskatchewan).

Teachers may wish to review these units prior to beginning this course. There may be content, teaching ideas, or resources that would be useful, particularly in the introductory units of the Energy and Mines curriculum. As well, opportunities may be found for collaboration with colleagues in resource sharing, joint program planning, or both.

## Work Study Component

This module permits the student to apply school-based learning to workplace settings in the community. Students are provided with an opportunity to experience the optional work study component through appropriate placements. Module 26: Work Study Preparation and Follow-up Activities must be covered prior to and following the work study module. The *Practical and Applied Arts Handbook* has detailed information in the "Work Study Guidelines" section. Students who have previously taken a work study module may cover content developed by Saskatchewan Labour found in the *Career and Work Exploration Curriculum Guide* and the *Practical and Applied Arts Handbook*. These content references include:
- Labour Standards
- Occupational Health and Safety Act
- Workplace Hazardous Materials Information System (WHMIS).

## Creating Partnerships for Work Study

Partnerships are important to the success of the work study component. There are three distinct partners that play an important role: the industry/business, the school and the student.

Personal contact is the best approach to building partnerships. One should begin by making a presentation to colleagues within the school, to the student body, to school board members, to parents and to local businesses. It is important to outline the curriculum and the benefits and responsibilities for each of the partners.

See the modules outlined in the curriculum and the "Work Study Guidelines" in the *Practical and Applied Arts Handbook* for further information on work study.

## Portfolios

A personal career portfolio is a valuable organizer of student projects and assignments. It encourages students to collect examples of their work as they progress through the various activities, labs and projects. Selecting particular items to include in a portfolio encourages students to reflect on what they have learned or accomplished and what they have yet to learn. Portfolio items may include: journal notes, drafts, photographs, audio or video tapes, computer discs, sketches and drawings, etc. Portfolios may be used for peer, teacher, self-assessment and as a format to present selected works to parents, post-secondary institutions or potential employers. In addition, the portfolio can demonstrate the link between home, school and community in the student's education. Each student should have a portfolio representing his or her work during the course.

The portfolio helps students:
- reflect on personal growth and accomplishment
- see links between home, school and community education and activities
- collect materials to prepare applications for post-secondary education and scholarship program entrance
- collect materials to prepare for employment applications
- focus on career planning.

The portfolio helps teachers:
- provide a framework for independent learning strategies for the student
- communicate student learning from one school year to another in a specific area of study
- identify career planning needs for students
- assess and evaluate the student's progress and achievement in a course of study.

The portfolio helps post-secondary institutions:
- determine suitable candidates for awards and scholarships
- evaluate candidates for program entrance
- evaluate prior learning for program placement.

The portfolio helps the community:
- reflect on the involvement in a student's education and the support offered to learners
- demonstrate the link between the home, school and community in education.

The portfolio helps potential employers:
- identify employable skills desired in future employees
- provide evidence of knowledge and skill development of potential employees.

## Working Portfolio

Students collect work over time in a working folder. Each student should also keep a journal of observations, critiques, ideas and reflections as part of his or her working portfolio. Items in this portfolio may be used for the purpose of reflection, for ongoing and summative evaluations, peer, teacher and self-evaluations, for documenting skill development and mastery.

Working portfolios may be used for purposes of conferencing between student and teacher, teacher and parent, teacher and teacher or student and student. When a teacher examines a student's portfolio in order to make a decision regarding student progress, the information it contains may become documented evidence for the evaluation.

A daily journal may also become a part of a working portfolio as a means of tracking the student's use of time and to record progress on ideas that are being developed. This will provide the student with a focus for self-directed or independent learning as well as an anecdotal record for part of the course evaluation.

## Presentation Portfolio

To compile a presentation portfolio, students should select items from their working portfolio. The presentation portfolio should cover the range of students' experiences and should display their best efforts. The preparation of a presentation portfolio can be an assessment strategy. It is strongly suggested that students at the 30 level prepare a presentation portfolio suitable for submission to potential employers or post-secondary institutions.

Through collecting, selecting and reflecting, students are able to compile presentation portfolios that display their best collection of work.

## Extended Study Modules

The extended study module is designed to provide schools with an opportunity to meet current and future demands that are not addressed by current modules in the renewed Practical and Applied Arts curriculum.

The flexibility of this module allows a school/school division to design one new module per credit to complement or extend the study of existing pure core modules and optional modules. The extended study module is designed to extend the content of the pure courses and to offer survey course modules beyond the scope of the selection of Practical and Applied Arts modules.

The list of possibilities for topics of study or projects for the extended study module approach is as varied as the imagination of those involved in using the module. These optional extended study module guidelines, found in the *Practical and Applied Arts Handbook*, should be used to strengthen the knowledge, skills and processes advocated in the Practical and Applied Arts curriculum in which the extended study module is used.

It is recommended that a summary of any extended study module be sent to the Regional Superintendent of Curriculum and Instruction to establish a resource bank of module topics.

For more information on the extended study module, refer to the *Practical and Applied Arts Handbook*.

### Instructional Resources

To support the principle of Resource-based Learning, a variety of instructional resources have been evaluated and recommended for the teaching and learning of Energy and Mines 10, 20, 30. See *Energy and Mines 10, 20, 30: An Initial List of Implementation Materials* for a list of annotated resources. Teachers should also consult the comprehensive Practical and Applied Arts bibliography. The annual L*earning Resource Materials Update* can also provide information about new materials evaluated since the curriculum was printed.

The on-line version of this Guide and the accompanying list of implementation materials is accessible at www.sasked.gov.sk.ca/docs/paa.html. It will be "Evergreened", as appropriate.

## Assessment and Evaluation

Student assessment and evaluation is an important part of teaching as it allows the teacher to plan and adapt instruction to meet the specific needs of each student. It also allows the teacher to discuss the current successes and challenges with students and report progress to the parent or guardian. It is important that teachers use a variety of assessment and evaluation strategies to evaluate student progress. Additional information on evaluation of student achievement can be found in the Saskatchewan Education documents *Student Evaluation: A Teacher Handbook*, 1991 and *Curriculum Evaluation in Saskatchewan*, 1991.

It is important that the teacher discuss the evaluation strategies to be used in the course, when the evaluation can be expected to occur and the weighting of each evaluation strategy and how it relates to the overall student evaluation. The weighting of the evaluation should be determined in relation to the amount of time spent and emphasis placed on each area of the course as suggested in the curriculum guidelines.

The *Energy and Mines 10, 20, 30 Curriculum Guide* provides many opportunities for teachers to use a variety of instructional and evaluation strategies. Evaluation instruments used in teaching this course are included in the *Practical and Applied Arts Handbook*. Sample copies of overall evaluation for the course, evaluation for general student skills and work study are included for teachers to adapt and use.

A sample evaluation scheme for this course:

| | |
|---|---|
| Portfolios | 10% |
| Written Tests | 10% |
| Practical Tests | 20% |
| Project Work | 30% |
| Assignments | 20% |
| Class Presentations or Work Study | 10% |

Regular program evaluation could include a survey involving parents, students and employers to determine program effectiveness and needs for change, if any. Information specific to program evaluation is found in Saskatchewan Learning's *School-Based Program Evaluation Resource Book* (1989) and the *Practical and Applied Arts Handbook*.

For more information about student evaluation refer to the *Practical and Applied Arts Handbook* (Saskatchewan Learning) or *Student Evaluation*: A *Teacher Handbook* (Saskatchewan Education, 1991).

For information about curriculum evaluation refer to *Curriculum Evaluation in Saskatchewan* (Saskatchewan Education, 1991).

## Module Overview

| Module Code | Modules | Suggested time (hours) |
|---|---|---|
| ENMI01 | Module 1. Introduction to Energy and Mines (Core) | 6-8 |
| ENMI02 | Module 2. Review of Saskatchewan Physical Geography (Core) | 4-8 |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | 10-15 |
| ENMI04 | Module 4: Sustainability (Core) | 10-15 |
| ENMI05 | Module 5: Oil and Gas - Formation, Location and Exploration (Optional) | 10-15 |
| ENMI06 | Module 6: Oil and Gas - Production (Optional) | 10-15 |
| ENMI07 | Module 7: Oil and Gas - Refinement, Use and Economic Effects (Optional) | 10-15 |
| ENMI08 | Module 8: Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional) | 10-15 |
| ENMI09 | Module 9: Electricity - Properties and Production (Optional) | 10-15 |
| ENMI10 | Module 10: Electricity - Transmission and Distribution (Optional) | 10-15 |
| ENMI11 | Module 11: Electricity - Workplace Safety, Environmental Safety and Careers (Optional) | 8-12 |
| ENMI12 | Module 12: Uranium - Formation, Location and Exploration (Optional) | 6-10 |
| ENMI13 | Module 13: Uranium - Production and Processing (Optional) | 8-12 |
| ENMI14 | Module 14: Uranium - Refinement, Distribution and Uses (Optional) | 8-12 |
| ENMI15 | Module 15: Uranium - Workplace Safety, Environmental Safety and Careers (Optional) | 10-18 |
| ENMI16 | Module 16: Coal - Formation, Location and Exploration (Optional) | 8-12 |
| ENMI17 | Module 17: Coal - Mining Methods, Production and Uses (Optional) | 5-8 |
| ENMI18 | Module 18: Coal - Workplace Safety, Environmental Safety and Careers (Optional) | 10-18 |
| ENMI19 | Module 19: Alternate Energy Sources - Heat (Optional) | 10-15 |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | 10-15 |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | 10-15 |
| ENMI22 | Module 22: Potash - Formation, Location and Exploration (Optional) | 6-10 |
| ENMI23 | Module 23: Potash - Mining and Production (Optional) | 7-10 |
| ENMI24 | Module 24: Potash - Refinement, Distribution, Use and Economic Significance (Optional) | 10-15 |
| ENMI25 | Module 25: Potash - Workplace Safety, Environmental Safety and Careers (Optional) | 10-15 |
| ENMI26A, B, C | Module 26: Work Study Preparation and Follow-up Activities (Optional) | 5-10 |
| EMNI27A, B, C | Module 27: Work Study (Optional) | 25-50 |
| ENMI99A, B, C | Module 99. Extended Study (Optional) | 5-20 |

## Suggested Course Configuration

The field test teachers felt that many schools would choose to offer only one credit of Energy and Mines. To aid in planning for one credit courses with a focus on a particular industry or geographic location, several course configurations are suggested.  Following these a suggested 3 credit course series is also offered.

| **Module Code** | **Petroleum Industry Focus** | **Suggested time (hours)** |
|---|---|---|
| ENMI01 | Module 1:  Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2:  Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3:  Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4:  Sustainability (Core) | 10–15 |
| ENMI05 | Module 5:  Oil and Gas - Formation, Location and Exploration (Optional) | 10–15 |
| ENMI06 | Module 6:  Oil and Gas - Production (Optional) | 10–15 |
| ENMI07 | Module 7:  Oil and Gas - Refinement, Use and Economic Effects (Optional) | 10–15 |
| ENMI08 | Module 8:  Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional) | 10–15 |
| ENMI21 | Module 21:  Alternate Energy Sources - Transportation (Optional) | 8–12 |
| ENMI99A | Module 99A:  Extended Study (Optional) | 5–20 |
| | **Minimum** | 100 |

| **Module Code** | **Uranium Industry Focus** | **Suggested time (hours)** |
|---|---|---|
| ENMI01 | Module 1:  Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2:  Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3:  Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4:  Sustainability (Core) | 10–15 |
| ENMI12 | Module 12:  Uranium - Formation, Location and Exploration (Optional) | 6–10 |
| ENMI13 | Module 13:  Uranium - Production and Processing (Optional) | 8–12 |
| ENMI14 | Module 14:  Uranium - Refinement, Distribution and Uses (Optional) | 8–12 |
| ENMI15 | Module 15:  Uranium - Workplace Safety, Environmental Safety and Careers  (Optional) | 12–18 |
| ENMI26A | Module 26A:  Work Study Preparation and Follow-up Activities (Optional) | 5–10 |
| EMNI27A | Module 27A:  Work Study (Optional) | 25–50 |
| | **Minimum** | 100 |

| Module Code | Electrical Industry Focus | Suggested time (hours) |
|---|---|---|
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4: Sustainability (Core) | 10–15 |
| ENMI09 | Module 9: Electricity - Properties and Production (Optional) | 10–15 |
| ENMI17 | Module 17: Coal - Mining Methods, Production and Uses (Optional) | 5–8 |
| ENMI10 | Module 10: Electricity - Transmission and Distribution (Optional) | 10–15 |
| ENMI11 | Module 11: Electricity - Workplace Safety, Environmental Safety and Careers (Optional) | 8–12 |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | 10–15 |
| ENMI14 | Module 14: Uranium - Refinement, Distribution and Uses (Optional) | 8–12 |
| ENMI99A | Module 28A: Extended Study (Optional) | 5–20 |
| | **Minimum** | 100 |
| | | |
| **Module Code** | **Southern Mining Focus** | **Suggested time (hours)** |
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4: Sustainability (Core) | 10–15 |
| ENMI22 | Module 22: Potash - Formation, Location and Exploration (Optional) | 6–10 |
| ENMI23 | Module 23: Potash - Mining and Production (Optional) | 7–10 |
| ENMI24 | Module 24: Potash - Refinement, Distribution, Use and Economic Significance (Optional) | 10–15 |
| ENMI25 | Module 25: Potash - Workplace Safety, Environmental Safety and Careers (Optional) | 10–15 |
| ENMI16 | Module 16: Coal - Formation, Location and Exploration (Optional) | 8–12 |
| ENMI17 | Module 17: Coal - Mining Methods, Production and Uses (Optional) | 5–8 |
| ENMI18 | Module 18: Coal - Workplace Safety, Environmental Safety and Careers (Optional) | 10–18 |
| | **Minimum** | 100 |

| Module Code | Alternate Energy Focus | Suggested time (hours) |
|---|---|---|
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4: Sustainability (Core) | 10–15 |
| ENMI19 | Module 19: Alternate Energy Sources - Heat (Optional) | 10–15 |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | 10–15 |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | 8–12 |
| ENMI26A | Module 26: Work Study Preparation and Follow-up Activities (Optional) | 5–10 |
| EMNI27A | Module 27: Work Study (Optional) | 25–50 |
| ENMI99C | Module 99C. Extended Study (Optional) | 5–20 |
| | **Minimum** | 100 |

Three Credit Course Series (10, 20, 30)

| Module Code | Energy and Mines 10 | Suggested time (hours) |
|---|---|---|
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | 6–8 |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | 6–8 |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | 10–15 |
| ENMI04 | Module 4: Sustainability (Core) | 10–15 |
| ENMI05 | Module 5: Oil and Gas - Formation, Location and Exploration (Optional) | 10–15 |
| ENMI06 | Module 6: Oil and Gas - Production (Optional) | 10–15 |
| ENMI12 | Module 12: Uranium - Formation, Location and Exploration (Optional) | 6–10 |
| ENMI16 | Module 16: Coal -- Formation, Location and Exploration (Optional) | 8–12 |
| ENMI19 | Module 19: Alternate Energy Sources - Heat (Optional) | 10–15 |
| ENMI22 | Module 22: Potash - Formation, Location and Exploration (Optional) | 6–10 |
| | **Minimum** | 100 |

| Module Code | Energy and Mines 20 | Suggested time (hours) |
|---|---|---|
| ENMI07 | Module 7: Oil and Gas - Refinement, Use and Economic Effects (Optional) | 10–15 |
| ENMI08 | Module 8: Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional) | 10–15 |
| ENMI09 | Module 9: Electricity - Properties and Production (Optional) | 10–15 |
| ENMI10 | Module 10: Electricity - Transmission and Distribution (Optional) | 10–15 |
| ENMI11 | Module 11: Electricity - Workplace Safety, Environmental Safety and Careers (Optional) | 8–12 |
| ENMI17 | Module 17: Coal - Mining Methods, Production and Uses (Optional) | 5–8 |
| ENMI18 | Module 18: Coal - Workplace Safety, Environmental Safety and Careers (Optional) | 10–18 |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | 10–15 |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | 8–12 |
| ENMI99B | Module 99B: Extended Study (Optional) | 5–20 |
| | **Minimum** | 100 |

| Module Code | Energy and Mines 30 | Suggested time (hours) |
|---|---|---|
| ENMI13 | Module 13: Uranium - Production and Processing (Optional) | 8–12 |
| ENMI14 | Module 14: Uranium - Refinement, Distribution and Uses (Optional) | 8–12 |
| ENMI15 | Module 15: Uranium - Workplace Safety, Environmental Safety and Careers (Optional) | 12–18 |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | 10–15 |
| ENMI23 | Module 23: Potash - Mining and Production (Optional) | 7–10 |
| ENMI24 | Module 24: Potash - Refinement, Distribution, Use and Economic Significance (Optional) | 10–15 |
| ENMI25 | Module 25: Potash - Workplace Safety, Environmental Safety and Careers (Optional) | 10–15 |
| ENMI26A | Module 26A: Work Study Preparation and Follow-up Activities (Optional) | 5–10 |
| EMNI27A | Module 27A: Work Study (Optional) | 25–50 |
| | **Minimum** | 100 |

# Core and Optional Modules

## Module 1: Introduction to Energy and Mines (Core)

**Suggested time:** 6-8 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
In the context of Practical and Applied Arts, it is appropriate to begin a study of Energy and Mines with some resource-based and some hands-on exploration. The module has been divided into two parts, the first focusing on energy, the second on mineral resources. Depending on the availability of resource materials and to encourage maximum student involvement, teachers may wish to have groups of students working on different objectives and activities at the same time.

**Foundational Objectives**
- To demonstrate knowledge of the diversity and significance of Saskatchewan energy and mining industries.
- To become familiar with the technology of the energy and mining industries.
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.

**Common Essential Learnings Foundational Objectives**
- To develop and practise appropriate research and analytical skills. (IL)
- To design effective ways of presenting information about energy and mineral resources. (COM)

| Learning Objectives | Notes |
|---|---|
| 1.1 To review forms and sources of energy in the context of human activity. | Energy concept web. Possible strategies:<br>• common *types* of energy: heat, light, electromagnetic radiation, electricity, wind, gravitational energy, nuclear energy, tidal energy, geothermal energy, chemical energy<br>• common energy *uses*: living, heating buildings, lighting homes, running appliances, transportation, manufacturing and industry<br>• common energy *sources*:<br>  ▪ Sunlight, heat, weather (wind), evaporation (water cycle), fossil fuels, biomass energy, wave action, photovoltaic energy<br>  ▪ Nuclei of radioactive elements<br>  ▪ Geothermal energy<br>  ▪ Gravitational – falling water and tides<br><br>Go through a day's activities and identify *daily energy uses*: turn on light and radio, have a shower (heat, pressure), eat breakfast (food and cooking), ride the bus. Identify sources of energy for each activity in a day. |
| 1.2 To become familiar with Internet resources pertaining to human use of renewable and nonrenewable energy resources. | What information about energy is available to the average Canadian? Do a web search, with keywords such as "sources energy utilization Canada" or access sites listed in the bibliography.<br><br>Identify advantages and limitations of each energy source; discuss renewable, nonrenewable, pollution, environmental issues, costs, byproducts etc. |

| Learning Objectives | Notes |
|---|---|
| 1.3 To demonstrate understanding of the principles of energy release, conversion and utilization. | Trace the movement and transformation of energy backwards to source (fusion in sun); e.g., where did Tina get the energy she used to run laps in gym this morning? Then trace energy forward; e.g., what happened to the energy after Tina converted it to motion?<br><br>Create and present a working model of an energy source. Make it generate mechanical activity, or make it light a bulb. Possibilities include water flow; water behind a dam or dike (e.g., tidal); burning fuels (fossil or biomass) to boil water and generate steam to operate a turbine; windmill or wind turbine; photovoltaic cell; chemical cell.<br><br>Discuss problems and limitations.<br><br>Try a "Junkyard Wars" activity where students construct an energy-transferring device from found materials (or materials provided by the teacher). |
| 1.4 To identify major Saskatchewan renewable and nonrenewable energy resources. | Using the *Atlas of Saskatchewan* or other sources, find and map Saskatchewan's population centres, major hydroelectric sources, thermoelectric sources, producing oil and gas fields, refineries, producing coal mines, oil and gas pipelines, electrical transmission lines with appropriate graphical indications of total energy output where applicable. Discussion: Is Saskatchewan self-sufficient in energy? |
| 1.5 To become familiar with the names, characteristics and commercial potential of Saskatchewan minerals and other products. | Do an Internet investigation of Saskatchewan's mineral resources.<br><br>Industry brochures and booklets are available. |
| 1.6 To become familiar with the physical appearance and characteristics of a variety of Saskatchewan minerals and geoproducts. | From a set of samples (preferably) or pictures, devise a dichotomous key to classify and identify Saskatchewan minerals and geoproducts. Use such characteristics as phase (liquid/solid), composition (organic/inorganic), colour, hardness etc. |
| 1.7 To become familiar with some of the commercial enterprises that engage in mining and its support activities in Saskatchewan. | Do a search of the websites of active companies, such as those listed in Bibliography.<br><br>Add to the list. Find out what role each plays, in mining or oil and gas exploration and development in Saskatchewan and present your findings to the class. |
| 1.8 To become familiar with local energy and mineral companies. | Students could contact municipal offices and other public agencies to assemble a community inventory of companies. Direct contact with company representatives for more detailed information could follow, thus laying the groundwork for further contact in Module 4 and subsequent modules. |

## Module 2: Review of Saskatchewan Physical Geography (Core)

**Suggested time:** 4-8 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
In this module students will review topographic features, climate and vegetation zones of Saskatchewan in the context of Western North America, particularly Western Canada.

**Foundational Objectives**
- To demonstrate knowledge of Saskatchewan's landforms and natural environments and their relation to renewable and nonrenewable resources.
- To foster an attitude of environmental responsibility.

**Common Essential Learnings Foundational Objectives**
- To use a variety of resources in collecting and interpreting data on climate and natural environments. (TL)
- To design effective ways of presenting data on geographic principles and Saskatchewan geography. (COM)

| | Learning Objectives | Notes |
|---|---|---|
| 2.1 | To review the basic principles of global climate determination and their contribution to the climatic patterns of the province and region. | Using encyclopedias, CD-ROM references, or web searches, explore and chart the basic determiners of global climate (solar radiation, temperature, precipitation, wind patterns, ocean currents, landforms) and explain the role of each in determining climatic patterns, with particular reference to northwestern North America.<br><br>The climate backgrounder in the Appendix can be a helpful reference. |
| 2.2 | To recognize the effect of climate in determining major patterns of plant (and animal) distribution. | From examination of vegetation maps of North America or the world, identify the major vegetation zones identified in the Vegetation Zone Backgrounder and their correlation with temperature and precipitation patterns.<br><br>The vegetation zones backgrounder in the Appendix can be a helpful reference. |
| 2.3 | To interpret a selection of climatic data with reference to specific Saskatchewan environments. | Using data from specific weather stations, prepare climographs for centres in northern and southern Saskatchewan (e.g., Cree Lake, Swift Current) and interpret and compare the results.<br><br>The climograph backgrounder in the Appendix can be a helpful reference. |
| 2.4 | To identify the resulting vegetation zones of Saskatchewan and their major flora and fauna. | Using *The Atlas of Saskatchewan* or similar reference, prepare a map showing the extent and distribution of Saskatchewan's two main vegetation zones and their major subdivisions. Identify key plants and animals for each and discuss some ways they are adapted to survive in their environment. |

| | Learning Objectives | Notes |
|---|---|---|
| 2.5 | To locate and identify key topographic features of the province and recognize the major effect of continental glaciation in shaping the topographic features of the province and region. | Using references such as *The Atlas of Saskatchewan* (2000) and *Geology of Saskatchewan: a Historical Approach*, (1975) prepare a map, poster or model showing the three prairie provinces' major rivers, lakes, hills and plains. Include features such as the edge of the Shield and the approximate locations of the Manitoba Escarpment and the Missouri Coteau. Explain the probable origin and significance of these features in the context of the most recent continental glacier (Laurentide ice sheet). |
| 2.6 | To identify local topographic features formed by glaciation or glacial meltwater and give an explanation for how they were formed. | Students could construct models or use a stream table to illustrate their explanation. |

# Module 3: Saskatchewan Geology and Geological History (Core)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** Module 1

**Module Overview**
This module will provide students with a context in historical geology for the origin and location of Saskatchewan's mineral and nonrenewable energy resources. Although the learning objectives are stated in generic form, it is expected that a Saskatchewan context will be introduced and emphasized wherever appropriate.

**Foundational Objectives**
- To demonstrate knowledge of the natural processes underlying the formation of mineral, coal and hydrocarbon deposits.
- To demonstrate knowledge of Saskatchewan's landforms and natural environments and their relationship to renewable and nonrenewable resources.
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.

**Common Essential Learnings Foundational Objectives**
- To cooperate with other students in designing, constructing and presenting models of geological processes and structures. (PSVS, COM)
- To gain facility with the large numbers associated with the geologic time scale. (NUM)

| | Learning Objectives | Notes |
|---|---|---|
| 3.1 | To recognize the fundamental differences between matter and energy: matter is not lost, but moves in different forms and associations through cyclic pathways, while energy, whatever its origin, passes one-way through a series of transformations and is eventually lost as heat (cf. Laws of Thermodynamics). | Review the activities carried out in L.O. 1.3 in the context of energy transformations. |
| 3.2 | To demonstrate basic understanding of the fundamental cycles of matter in the earth's mantle, crust and atmosphere, including the hydrologic (water) cycle, the mineral and rock cycles including plate tectonics and the carbon/carbonate cycle and the role of these cycles in the formation of mineral and energy resources. | Students could construct and present drawings or static or working models, of the hydrologic cycle, the rock and the mineral cycles, the carbonate cycle. |
| 3.3 | To recognize the geological processes of weathering and erosion as fundamental to the transformation of the earth's land surfaces over time. | Students could construct and present drawings or static or working models, of geological processes, including weathering of rock through abrasion, freeze/thaw cycles, action of carbonic acid, deposition of graded sediments from soil, clay, sand and gravel mixtures. Students could, for example, model some erosional processes using a stream table and illustrate depositional layering using a sediment tube. |

| | Learning Objectives | Notes |
|---|---|---|
| 3.4 | To explain the formation of sedimentary strata in terms of origin of sedimentary material, transport, deposition and lithification and the role of sedimentary strata in the preservation of fossil materials (including fossil fuels). | Students could construct and present drawings or two- or three-dimensional models of:<br>1. The formation of the Saskatchewan portion of the western sedimentary basin (see activity in Gordon, *Geology of Saskatchewan: A Historical Approach* (1975); see *Atlas of Saskatchewan* (2000) for background and illustrations).<br>2. Formation and preservation of coal and petroleum. |
| 3.5 | To recognize and explain the significance of fundamental scientific principles of historical geology in understanding the present nature of the earth's surface, crust and sedimentary strata: the Principle of Uniformitarianism, the Principle of Superposition, the Principle of Faunal Succession and the Theory of Continental Drift. | Students could construct and present drawings and maps or static or working models of geological processes and principles such as plate tectonics, continental drift, earthquakes, volcanic activity, fossils and the geological timetable, relation of geological processes to locations of Saskatchewan mineral resources, as identified in Module 1.<br><br>It is expected that, whatever their personal belief system may prescribe, students will strive to *understand* the generally accepted scientific theories and principles underlying the study of earth history. Teachers who choose to explore or debate "alternative theories" of origins should be prepared to discuss the nature of scientific theories in general. See the note for L.O. 5.2. |
| 3.6 | To demonstrate an understanding of the expanse of geologic time and some techniques for measuring it and to be familiar with the major geologic time periods as summarized in the Worldwide Geological Column. | Students could construct and present drawings or models of geological processes and principles such as fossils and the geological timetable, radioactive elements and absolute dating techniques, the Worldwide Geological Column and its relationship to vertical sections at various Saskatchewan locations. A scale physical model, perhaps on a long string in a hall or outside with markers on the ground, can be helpful for students to grasp the extent of geologic time and the relative shortness of recorded history. One school in the province made fossil impressions in a newly poured sidewalk at appropriate locations to create a scaled timeline. The models of fossils used to make the impressions in the concrete were made from clay in art class.<br><br>Teacher Reference: Earth history backgrounder, Appendix A. |
| 3.7 | To be aware of what geological scientists say was happening in the local area at various times in geological history. | Students could construct dioramas or make drawings of the probable environment at various times in the past. Alternatively, they could develop a "time machine" dramatization, in which various environments are visited and described. |

# Module 4: Sustainability (Core)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** Module 1

**Module Overview**
Sustainable development focuses on improving the quality of life without increasing the use of natural resources beyond the capacity of the environment to supply them indefinitely. The most frequently quoted definition of sustainable development is from the report *Our Common Future* (also known as the Brundtland Report):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In this module, in the light of the knowledge acquired in the first three modules, students will focus more deeply on the nature of resource exploitation, in the context of economic, social and environmental responsibility.

**Foundational Objectives**
- To demonstrate knowledge of the diversity and economic, social and environmental significance of Saskatchewan energy and mining industries.
- To become familiar with the technology of the energy and mining industries.
- To foster an attitude of environmental responsibility.

**Common Essential Learnings Foundational Objectives**
- To develop appropriate research and analytical skills to gather, examine and interpret statistical data. (IL, NUM)
- To articulate, examine and debate the ethical and social impact of alternative courses of action. (PSVS, COM, CCT)
- To gather and interpret information on complex social and environmental issues, from a variety of primary and secondary sources. (IL, TL)

| | Learning Objectives | Notes |
|---|---|---|
| 4.1 | To collect and interpret data comparing Canadian energy and resource consumption to the rest of North America and the rest of the world. | To provide a context for subsequent discussions of sustainability, students should try to find data on Saskatchewan's per capita consumption in comparison to the rest of the world. Detailed and reliable data are not easy to find. Students should be careful to check the reliability of their sources of information, particularly on the World Wide Web. (CCT) |
| 4.2 | To collect and interpret data on the economic impact of the energy and mining industries on the local, provincial and national economies. | From provincial and federal government websites, collect, display and interpret numerical data on production, proven and probable reserves, economic value and employment in various sectors of the energy and mines industries. A comparison of data from different sources: government, industry and environmental groups could be a worthwhile exercise for students. |
| 4.3 | To assess community views on the social impact of the energy and mining industries on families and local communities. | Design and conduct a survey of community opinion on the benefits and problems associated with local or provincial energy or resource extraction industries. |

| | Learning Objectives | Notes |
|---|---|---|
| 4.4 | To explore the environmental impact, both short-term and long-term, of common methods of mineral resource exploration, extraction, transportation, processing and consumption. | Conduct a web search and prepare flow charts on the technology of extraction and processing for various Saskatchewan minerals, along with assessment of environmental impact and strategies for reclamation. |
| 4.5 | To explore the potential environmental impact, both short-term and long-term, of common methods and levels of energy generation, transport and consumption. | Students could prepare visual presentations on the basic technology of various forms of energy production, their advantages and disadvantages. |
| 4.6 | To examine the implications of Saskatchewan's current and "sustainable" levels of energy use, in the context of climate change and global warming. | This particular issue is topical enough to deserve a separate learning objective from the more general discussion in L.O. 4.5. There are several Saskatchewan-based action initiatives and sources of resources.<br><br>Students could try to predict the effects of global warming-induced climate change on their local area and the province as a whole. They could illustrate their predictions with maps or computer animations.<br><br>Students should explore methods by which they personally might contribute to a reduction in greenhouse gas production either directly or indirectly. They could be encouraged to initiate personal or school-wide projects in this area.<br><br>Connection can be made with Science 10 Units A-2, B-2. |
| 4.7 | To examine the implications of a goal of sustainable development, in the context of selected Saskatchewan energy resources. | Organize a community panel or conduct a debate on the meaning of and strategies for, sustainable development, in selected resource industries. |
| 4.8 | To examine the implications of a goal of sustainable development, in the context of selected Saskatchewan mineral resources. | |

## Module 5: Oil and Gas - Formation, Location and Exploration (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
The first of four Oil and Gas modules, Module 5 focuses on formation of petroleum resources, location and geological history of petroleum producing areas in Saskatchewan and methods used to explore for petroleum deposits. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.
- To understand the geological and geophysical principles underlying the process of resource exploration.
- To become familiar with the technology of the energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To become familiar with the nature of scientific theories and their application. (CCT)
- To practise accurate terminology in describing the science and technology of petroleum geology. (COM)
- To practise interpreting numerical scientific data. (NUM)

| | Learning Objectives | Notes |
|---|---|---|
| 5.1 | To differentiate between oil and gas. | **Oil** is a liquid mixture of hydrocarbons and is the source of all liquid fuels including gasoline.<br><br>**Gas** is gaseous mixture of the hydrocarbons methane, propane and butane.<br><br>Students could begin a glossary of terms related to oil and gas and the petroleum industry and continue it through subsequent modules. |
| 5.2 | To understand the conventional theory explaining the formation of petroleum deposits. | The conventional theory, believed by most earth scientists, is that the earth's petroleum formed during the Cretaceous Period of the Mesozoic Era, transformed and reduced from the lipid-rich remains of microscopic marine organisms by heat and pressure.<br><br>Dr. Thomas Gold of Cornell University has an interesting alternative theory. An Internet search will yield many sites about Gold's and other theories, including some creationist ones. The hallmark of a valid scientific theory is its falsifiability, i.e., its ability to generate testable hypotheses that can be confirmed or rejected. Does the conventional theory meet that criterion? Do the alternative theories? |
| 5.3 | To understand that petroleum and other fluids move within the earth's crust and describe the manner of this movement in the context of rock porosity and permeability. | The rock formations that contain petroleum and water are mostly solid, yet permeated by fine pores. Students should be given opportunity to examine reservoir rock.<br><br>Students could conduct a demonstration of the way oil, water and sand separate. Students might also design and carry out an investigation to measure the porosity and permeability of containers of different substances, from sand to marbles. Which has greater porosity, large particles or small? |

| | Learning Objectives | Notes |
|---|---|---|
| 5.4 | To identify oil and gas producing areas in Saskatchewan and Canada. | Students can plot these on a provincial map or model, if they have not already done so in Module 1. This activity could be extended to a comparison of production and estimated reserves for Canada's major producing fields, or by province or region. |
| 5.5 | To describe the petroleum-bearing formations for each oil and gas producing area in Saskatchewan. | Details about which information is collected and displayed should include:<br>• name and geologic age of the formation<br>• the geologic processes that created the formation<br>• geography of the surface landscape<br>• depth of producing zones<br>• types of rock in formations<br>• types of oil traps<br>• nature of the petroleum product – oil/gas ratio, sulfur content etc.<br>• amount of petroleum produced and the amount left (reserves).<br><br>In-depth study of the local area may be appropriate where schools are near producing fields. A class or group of students could construct a three-dimensional scale model of the local area. |
| 5.6 | The student will demonstrate familiarity with the various types of oil traps. | While most Saskatchewan petroleum is in stratigraphic traps, anticlinal traps and fault traps are also prominent in reference books. Reef traps in Alberta and salt dome traps in Texas are also well known. Middle East oil is in a much different environment than Saskatchewan's; students might investigate the differences. |
| 5.7 | To recognize the relationship between the large-scale geology of an area and the process of locating oil. | Students should understand that potentially petroleum-bearing rock formations may cover large areas, both above and below surface and that a model of what lies beneath is built up from a combination of outcrop observation and well log and drill hole data. |
| 5.8 | To understand the theory and practice of seismic exploration. | Students could perform various activities that demonstrate indirect methods of finding information -- for example, inferring the shape and size of unknown objects in sealed boxes.<br><br>Students could investigate and make a visual presentation of the work done by a seismic crew.<br><br>Students could construct and test a model geophone system.<br><br>Students could use sample seismic data to make predictions regarding the presence of hydrocarbon- bearing rock structures.<br><br>Students could examine and present the pros and cons of three-dimensional versus two-dimensional seismic data, considering cost, amount of data used, ease of interpretation and clarity of subsurface images. |

| Learning Objectives | | Notes |
|---|---|---|
| 5.9 | The student will explore the theory and practice of geophysical or other exploration techniques useful in locating potential petroleum-bearing sub-surface formations, including<br>• gravity field measurement<br>• magnetic field measurement<br>• aerial surveys<br>• satellite imagery | While these techniques may not merit a lot of class time, students should be aware of their existence and be able to describe them briefly. |

## Module 6: Oil and Gas - Production (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn about drilling, testing and producing a well and collecting and transporting crude oil. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Module 5 in a pure course.

**Foundational Objectives**
- To become familiar with the legalities of resource exploration and production.
- To become familiar with the technology of the energy and mining industries.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.

**Common Essential Learnings Foundational Objectives**
- To use correct terminology to describe the various processes and technologies. (COM)
- To cooperate in constructing accurate scale models or drawings of oil drilling and production sites. (COM, NUM, PSVS)

| Learning Objective | Notes |
|---|---|
| 6.1 To understand the distinction, in land ownership, between mineral rights and surface rights, will outline the steps an oil company must take in acquiring mineral rights and property access prior to drilling and will identify some potential positive and negative consequences for landowners. | Students should be aware of the treaties between the First Nations and the government of Canada and how they impact exploitation of sub-surface minerals. An investigation of reserve lands and land claims in the context of mineral and subsurface rights and oil and gas exploration could be done. Numerous websites discuss this issue; a search using keywords like “First Nations” + “land” + “oil exploration” should get them started.<br><br>Students should understand the basic structure of the Saskatchewan land survey system and how land titles are identified under that system.<br><br>Students could explore land titles and rights, including the rights of those who hold leases for grazing rights on Crown land, by interviewing local landowners, leaseholders, or municipal officials. Students could explore why ownership of most mineral rights is in the hands of the provincial government, with only a small portion held by landowners.<br><br>The right to exploit a subsurface deposit is usually gained through a government sale of mineral rights. A simulated sale could be carried out in class, using data similar to that collected in Module 5 about several pieces of property that are up for option. Students, or teams of students, could estimate the value of different properties, before bidding on them in an auction. The auction simulation could be extended into the access rights to drilling sites, with the buyers of rights in the auction having to negotiate with "landowners". |

| Learning Objective | Notes |
| --- | --- |
| 6.2 To describe site preparation, the parts and operation of a drilling rig and the jobs associated with a working rig. | Students could continue adding terms to a glossary, if they began one in Module 5.<br><br>Students could construct scale models of rigs and drilling sites. They should be familiar with the space requirements, site preparation, rig set-up and procedures such as rotating, hoisting and circulating. The environmental impact of drilling a well and measures that are taken to minimize the impact should be investigated.<br><br>Different depths of holes require different rigs. Students could compare depth of wells drilled in Saskatchewan fields to those in other places. What is the deepest well ever drilled and what are special challenges that accompany deep wells? What is the average well depth in the foothills of Alberta? In the Arabian peninsula? |
| 6.3 To identify specific safety procedures, blowout prevention and other environmental protection procedures normally observed at a drilling site. | This objective can be expanded in Module 8. It is introduced here in the event that a tour of a drilling site can be arranged in conjunction with this module. |
| 6.4 To describe the roles of various specialist services associated with drilling sites. | Such services might include<br>• mud logging<br>• well geology<br>• well logging<br>• coring<br>• drillstem testing<br>• casing and cementing<br>• environmental assessment. |
| 6.5 To identify major factors affecting whether a well, once drilled, is brought into production. | Students could investigate the rates of success, costs and other factors in the decision to produce a well. Royalties on production and government incentives for drilling should be included in the costs. A comparison of royalties and incentives in Saskatchewan with those in Alberta is instructive.<br><br>Students should also be aware of the costs and requirements for abandonment of a "dry hole"-- a well that is not economical to produce. |

| Learning Objective | Notes |
|---|---|
| 6.6 To recognize the steps necessary to bring a well into production. | Such steps might include<br>• installation of production casing<br>• installation of production tubing<br>• identification of producing zones and packer installation<br>• perforation<br>• pumping<br>• stimulation, including acidizing and fracturing.<br><br>Students should learn about the differences between oil and gas wells and the way that both oil and gas can be produced from a single well. |
| 6.7 To describe the operation of a typical producing well, including the purpose and procedures of well servicing and the methods of transporting and collecting the products at the production field. | Students should be familiar with the operation of service rigs and the functions they perform.<br><br>Consideration should be given to various types of wells and recovery methods used in Saskatchewan oilfields. For example, different production zones need different equipment at the wellhead to extract the product, e.g., free flowing wells, wells that require pumps and pump jacks. Here the principles of a lift pump might be explored by means of diagrams or working models. Further, different recovery methods are used for light and heavy crude oil. Students could inquire as well into the $CO_2$ enhanced recovery project on which Pan Canadian and the University of Regina are working.<br><br>As an enrichment topic, some students might like to explore the purpose and method of horizontal drilling and how the resulting wells are operated and serviced.<br><br>Students might also explore the technology by which petroleum is extracted from oil sands and tar sands.<br><br>As a concluding activity and a transition to Module 7, an oil extraction and refining simulation could be conducted in which each team is provided with a 2 litre plastic pop bottle containing a mixture of sand, salt, vinegar and used engine oil, sealed with a layer of paraffin that has been melted, poured in and allowed to harden. The teams then work to see who can safely and effectively extract the most oil from their bottle. Teams could then be asked to explore refining methods to separate their oil from the salt and vinegar. |

## Module 7: Oil and Gas - Refinement, Use and Economic Effects (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn about handling, storing and distributing oil and gas and about refining processes for crude oil. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 5 and 6 in a pure course.

**Foundational Objectives**
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.
- To demonstrate knowledge of the diversity and the economic, social and environmental significance, of Saskatchewan energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To practise flowcharting and related process modeling. (COM, CCT)
- To construct and analyze operating pipeline models. (TL, CCT)

| | Learning Objective | Notes |
|---|---|---|
| 7.1 | To identify and describe the various chemical components of Canadian crude oil. | Students could prepare charts with names, chemical formulas and identifying physical and chemical characteristics of the major components of crude petroleum, including both hydrocarbons and other components (impurities, contaminants). Students should be aware, as well, that raw oil and gas is not all the same and that significant differences exist in the proportions of hydrocarbons and other substances produced from different wells and fields. |
| 7.2 | To describe the stages of processing necessary to create marketable natural gas from natural gas in its raw form as it comes from the wellhead, as well as the usual methods of handling, storing, or disposing of processing by-products. | Flaring of $H_2S$, de-watering, removal of sulfur and $CO_2$ are processes usually carried out at a gas plant in the production field.<br><br>Students could investigate the major gas fields in Saskatchewan to discover which contaminants are prevalent in the gas from each. They could also compare raw gas from Saskatchewan with that from other localities. |
| 7.3 | To identify the two Canadian pipeline systems (crude oil and natural gas), their sources, tributaries and destinations. | Students could chart the pipelines on a map, including sources and destinations. They could also identify the companies that own the pipelines.<br><br>Following up on activities from Module 1, students could investigate Saskatchewan companies such as SaskEnergy, TranGas and others and their roles in natural gas production and distribution. |

| | Learning Objective | Notes |
|---|---|---|
| 7.4 | To explain the mechanics of the movement of oil and gas through pipelines. | Students could examine how pipelines are sited and constructed (including in mountains and underwater), the diameter and thickness of the pipes themselves, the pressures and flow rates they must withstand, the methods of testing and the nature of pumping and pressure systems. They should be familiar with procedures for inspection and maintenance, including the use of Pipeline Internal Gauges (PIG).<br><br>Students could try to construct working pipelines from soda straws and tape or glue, showing how they have tried to meet the sometimes conflicting requirements of efficiency, cost-effectiveness and safety.<br><br>To get a feel for the dynamics of pipeline construction, students could try building model pipelines with plastic pipe and valves. |
| 7.5 | To explain the crude oil refining process and the methods by which specific end products, both fuels and petrochemicals, are created. | Consideration should be given both to heavy oil upgrading and to fractional distillation and its products. Flowcharting the path from crude oil to finished product is worthwhile. Students could do more detailed flowcharts of individual processes as part of a class project. As a followup, a comparison could be made of the values of various end-product commodities. From these, estimates could be made of the value added to crude oil or natural gas in the refinement process.<br><br>If the class is not already familiar from science classes with the process of fractional distillation, a supervised team of students might be allowed to demonstrate the process in the chemistry lab. |
| 7.6 | To demonstrate familiarity with the companies that produce, refine and market petroleum products in Saskatchewan and Canada. | A class project could investigate oil, gas and petrochemical companies and their ownership. Students could begin with the local gas station and work back through refining and production. Company size and value can often be found on the Internet, as most companies are publicly traded. |

## Module 8: Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore occupational and environmental safety standards and their implication for the petroleum and petrochemical industries. As well, students will investigate the social impact of the oil and gas industry, with emphasis on career and employment opportunities. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 5, 6 and 7 in a pure course.

**Foundational Objectives**
- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To develop a critical appreciation of the standards of occupational health and safety within the industry. (CCT)
- To develop a critical appreciation of the environmental standards and regulations that apply to the industry. (CCT)
- To examine community concerns regarding the impact of oil and gas exploration, drilling, extraction, transport and processing. (PSVS, CCT, COM)
- To explore career opportunities in the petroleum industry using the Internet. (TL, IL)

| Learning Objectives | Notes |
|---|---|
| 8.1 To become familiar with the safety regulations, procedures, equipment and personnel at local or regional petroleum-based industries and sites. | Companies in the petroleum and petrochemical industries are very concerned about worker safety. Students could interview managers, safety officers and workers from local petroleum-based industries and prepare reports on potential hazards, occupational heath and safety laws and regulations, enforced safety procedures and drills, safety and emergency equipment and training, ongoing safety programs and specialist training. Site tours would provide added depth. |
| 8.2 To investigate the potential environmental effects of oil and gas exploration, drilling, extraction, transport and processing. | Students could do research or conduct interviews to determine the environmental issues that are of local or general concern. They could identify probable wastes and by-products and investigate the potential effect of these on surface water and the water table. They could examine the dispersal by wind of escaping gases, gaseous by-products and wastes from burn-off and the potential impact of these on the air, water, soil, plants, animals and people of neighbouring farms and communities. |

| Learning Objective | Notes |
|---|---|
| | Students could set up an experiment in which potted plants are exposed to varying concentrations of some of the waste products produced by local industries and compare concentrations that produce visible effects with the concentrations actually released by the industry, to test the accuracy of the saying, "Dilution is the solution to pollution". If this is done a discussion of the limitations of the experiment should occur. The question "If no effect is visible, does that mean everything is fine?" should be considered along with long-term or invisible effects and biomagnification. |
| 8.3 To become familiar with the legislation in place to protect the environment and how it is applied in practice. | Before drilling can take place, the company must have done an impact assessment and report. The company is also required to present a plan, with finances in place, to show reclamation procedures. As well as examining samples of these reports, students might explore the financial impact of environmental legislation on the costs of bringing a well to production.<br><br>Students should also research and report on the nature and frequency of tests done to monitor the environment and the standards of the well, refinery, or other facility. |
| 8.4 To identify and assess the consequences of failure of one or more waste management programs or controls, whether through accident or failure to follow established procedures. | Students could identify emergencies that might arise (e.g., blowout, fire, dike failure, leaking storage tank, tanker truck spill, pipeline rupture) and the solutions in place for these emergencies, as well as the immediate and long-term effects. Students could investigate real emergencies and find out what happened. |
| 8.5 To discuss the economic and social impact, both positive and negative, of local petroleum-based industries on the community, families and individuals. | Students could research, conduct interviews or simply brainstorm to assess how local industry affects public services, housing, schools, construction, food services, shopping, recreation, etc. They might also be encouraged to examine the social effects of a fluctuating or transient population and the effects of varying work schedules and seasonal or cyclical employment on the quality of life for individuals and families.<br><br>Students could participate in a "Town Hall Meeting" to discuss the pros and cons of local industry introduction or expansion. A hypothetical situation could be set up with each student or groups of students representing a community organization that either is for or against the proposed development. Students would discuss/argue as to the benefits or detriments of the project. A student "Mayor" could chair the meeting, or a community leader could be invited to preside. |

| Learning Objective | | Notes |
|---|---|---|
| 8.6 | The student will demonstrate familiarity with employment opportunities and careers in the petroleum industry. | Students could develop a list of careers or jobs, either local or throughout the industry and categorize each as professional/non-professional, technical/non-technical, permanent/seasonal, full time/part time.  Students could also explore issues of gender equity in the careers of the petroleum industry.<br><br>Students could report on one specific career in the industry after research, interviews and, where possible, work study or job shadowing. |

## Module 9: Electricity - Properties and Production (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will develop basic information about the nature and behaviour of electricity. As well, they will explore, in greater depth than in Modules 1-4, the common methods of electrical generation, with emphasis on those methods used in Saskatchewan. The teacher may wish to examine the early modules of the PAA courses *Electrical and Electronics 10, 20, 30* and Unit III of the Science course *Physics 30* for basic information and ideas and to make an assessment of how much detail is appropriate for the difficulty level and time allotment of the present program. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those methods used in Saskatchewan.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.

**Common Essential Learnings Foundational Objectives**
- To become familiar with and use the terminology of electricity and electrical production. (COM)
- To research and present information about electrical generation. (COM, TL)

| Learning Objective | Notes |
|---|---|
| 9.1 Using correct terminology, the student will demonstrate a basic understanding of the nature of electrical energy and its movement through conducting materials and circuits. | Students could construct water-based analogues to facilitate an understanding of potential difference, current, resistance and power. This should lead to discussion and definition of standard SI units.<br><br>Students could construct simple low-voltage DC circuits and practise correct use of commercial multimeters to read voltage, current and resistance in series circuits. |
| 9.2 To demonstrate facility with Ohm's Law and power (wattage) determination in simple calculations. (NUM) | Students could practise calculations by following up on the circuit measurements in L.O. 9.1. The inevitability of measurement error may, however, lead to more confusion than clarification. |
| 9.3 Using appropriate terminology, the student will describe common methods of commercial electrical generation, identify the energy source in each case and indicate whether the energy source is renewable or non-renewable. | Students could briefly review the portions of Modules 1 and 4 that apply to electrical energy.<br><br>Methods of electrical generation that might be explored in more detail via Internet and print resources should include hydroelectric, fossil fuel based (coal, oil and gas-based thermoelectric, plus gas turbines), nuclear, solar, wind, geothermal, tidal and co-generation strategies.<br><br>Students could begin a glossary of electricity-related terms. |

| Learning Objective | Notes |
|---|---|
| 9.4 To locate and describe the various commercial electrical generating facilities in Saskatchewan. | Facilities currently operating in Saskatchewan include the following:<br>• Steam turbine (thermal) stations<br>  ▪ Boundary Dam (coal fired)<br>  ▪ Poplar River (coal fired)<br>  ▪ Shand (coal fired)<br>  ▪ Queen Elizabeth (natural gas fired)<br>• Natural gas turbine stations<br>  ▪ Landis<br>  ▪ Meadow Lake<br>  ▪ Success<br>• Water turbine (hydraulic or hydroelectric) stations<br>  ▪ Athabasca (3 stations)<br>  ▪ Coteau Creek<br>  ▪ E.B. Campbell<br>  ▪ Nipawin<br>  ▪ Island Falls<br>• Other<br>  ▪ Sunbridge and SaskPower wind generation<br>  ▪ Cory Potash Mine co-generation<br><br>Students may have mapped these facilities in Module 1 (L.O. 1.4). At this point, emphasis should be placed on a more detailed understanding of the various methods of electricity generation, the production capacity of each Saskatchewan facility and the role each facility plays in generating electricity for the province. |
| 9.5 To model or construct and explain the operation of a simple water turbine, steam turbine, or gas turbine. | If facilities and safety considerations permit, working models rather than stationary or scale models might be constructed and demonstrated by teams of students. If rotational energy from a turbine shaft can be harnessed to drive a small generator that powers a bulb or buzzer, so much the better. Generators used to power bicycle lights are easy to adapt for this purpose. |
| 9.6 To collect and present information on the details of the design and operation of one specific electrical generation facility in Saskatchewan. | This objective would most appropriately be met by a guided tour of an electrical generation facility, including taking photographs or videotaping aspects of the visit and interviewing key personnel.<br><br>If such a tour is not possible, a film or video, combined with a guest speaker, might be substituted. Either way, students might be expected to prepare displays or presentations on the technology, the kinds of jobs and training requirements and worker safety and environmental protection provisions.<br><br>Because this project is correlated with learning objectives in Modules 9, 10 and 11, the teacher may wish to complete the appropriate portions of Modules 10 and 11 before completing L.O. 9.6. |

| Learning Objective | Notes |
|---|---|
| 9.7 To make and support predictions about future trends in Saskatchewan's electrical production and consumption. | Through examination of statistics on patterns and projections of domestic and industrial electrical consumption, potential export markets for Saskatchewan surplus electrical production and/or potential costs of importing electricity to meet future shortfalls, students could explore possible future scenarios. How might increased domestic demand or increased export potential be addressed by government? What kinds of generating facilities would be most likely to be built? Where would they be located? |

## Module 10:  Electricity - Transmission and Distribution (Optional)

**Suggested time:** 10-15 hours　　**Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn basic properties of Alternating Current and safety precautions in its handling.  They will learn how electricity is transformed, distributed, regulated and sold commercially and how the power grid system is designed and maintained.  This module is assigned no prerequisites to facilitate its use in survey courses.  However, it should be preceded by Module 9 in a pure course.

**Foundational Objectives**
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the technology of the energy and mining industries.
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.

**Common Essential Learnings Foundational Objectives**
- To become familiar with terminology that describes electricity and its production, transmission and distribution.  (COM)
- To demonstrate an ability to research information using Internet sources and print material.  (COM, TL, CCT)
- To practise numerical skills in calculating power consumption from meter readings and in calculating electrical bills.  (NUM, TL)

| Learning Objective | Notes |
|---|---|
| 10.1 To know the basic properties of alternating current, to understand the differences between AC and DC circuits and to be able to state the advantages of AC over DC for commercial electrical distribution. | The teacher may once again wish to refer to the *Electrical and Electronics 10, 20, 30* and *Physics 30*, curricula for ideas and guidance.  Students could conduct web or library searches to develop basic knowledge, then interview local experts such as physics teachers, commercial or industrial electricians, or SaskPower personnel, to fill in the gaps.<br><br>Students could add new terminology to their glossary, if they began one in Module 9. |
| 10.2 To be familiar with the voltages carried, visual appearance, location and total number of kilometres, for the various sizes of transmission lines in the Saskatchewan power grid. | Students could use the Internet, print or CD-ROM materials from local libraries or SaskPower offices to find the location, appearance, size and capacity of the transmission lines and towers in the province.  Using graphs or tables, comparisons could be made with neighbouring jurisdictions, on both a total and a per capita basis.<br><br>Students could do a survey of transmission lines and switching stations in the area.  Diagrams and models of different line structures and their components could be made.  Theories about the need for and use of different components could be formulated and checked with resource people or reference materials. |

| Learning Objectives | Notes |
|---|---|
| 10.3 To describe the control systems that regulate the SaskPower grid and identify the role of electrical substations in the power grid, including the purpose and function of step-up and step-down transformers. | Some information on control systems is available from the SaskPower website; exposure through a guided tour, or at least a film or video, would be preferable.<br><br>Students could visit a local substation under the guidance of a SaskPower employee and prepare a display or diagram of the facility.<br><br>Students could perform simple mathematical calculations on coil sizes and voltage ratios in transformers. |
| 10.4 To describe and explain the process by which electricity is distributed from local transformers to residences, businesses and public buildings. | Students should be familiar with the appearance and characteristics of common types of transformers that convert 25KV or 14.4KV to 110/220VAC and be able to trace the path of the current from transformer to meter to service panel to outlets or appliances. Students should know the basis for selecting the size of electrical service panel required for a particular facility and be familiar with circuit load, conductor size and common methods of overload protection (including fuses, circuit breakers and GFI outlets). Students should understand the difference between two- and three-conductor circuits and the method by which 110VAC and 220VAC are obtained from the same service panel. |
| 10.5 To recognize and read common types of electrical utility meters and calculate service fees based on meter readings and fee schedules. | Based on the information in the Customer Services section of the SaskPower website, the teacher or students could develop sample user scenarios and meter readings and practise calculating billing charges.<br><br>Students could visit commercial establishments with demand meters and compare and contrast demand metering with normal residential supply metering.<br><br>Students could be provided with sample utility bills to analyze and interpret. |
| 10.6 To describe the characteristics of the interprovincial power grid and explain how power outages and demand overload are handled to minimize service disruption. | Students could interview, email, or write letters to SaskPower officials to obtain this information.<br><br>Students could explore the implications of SaskPower's proposed Open Access Transmission Tariff in the context of import, export and carrying electricity on behalf of other owners or producers both inside and outside the province.<br><br>The role of large industrial and institutional users, such as IPSCO, potash mines, the Canadian Light Source (Synchrotron) and their impact on the power grid could be investigated. |

| Learning Objectives | Notes |
|---|---|
| 10.7 To demonstrate familiarity with the job classifications and skill requirements of the workers who design, construct, maintain and operate the SaskPower grid. | Students could explore the Training Programs link on the SaskPower website to become familiar with the kinds of jobs, specific skill requirements and safety training features. In particular, the details of the Lineman Apprentice Program might provide useful information.<br><br>Much of the content of this objective overlaps that of Module 11; the difference is mainly one of emphasis. In the present module the focus is on operation of the system, while Module 11 looks at careers, training and safety requirements. The teacher may nevertheless wish to combine the relevant learning objectives into a single student activity. |
| 10.8 To be familiar with the basis for assessing future electrical transmission needs for Saskatchewan and with the steps that must be taken before a new transmission line is constructed. | Students could contact their local MLA and/or SaskPower managers to become familiar with government and corporate priorities, planning and policy. Who determines whether new power lines and substations are needed? Who pays? Who has a say in determining location? Who makes the final decisions? Students could report their findings to the rest of the class.<br><br>Students could conduct a "Town Hall Meeting" dealing with a proposed power line or substation, in which they play the roles of various interest groups, e.g., homeowners, cottage owners, farmers, wildlife/environmental organizations, business interests, First Nations. Planning could include a local MLA, civic official, or SaskPower official as moderator or keynote presenter. See also L.O. 11.5. |

## Module 11: Electricity - Workplace Safety, Environmental Safety and Careers (Optional)

**Suggested time:** 8-12 hours **Level:** Introductory
**Prerequisite:** None

### Module Overview

Students will explore occupational and environmental safety issues and standards and their implications for the electrical industry. Students will also investigate career and employment opportunities in the industry. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 9 and 10 in a pure course.

### Foundational Objectives

- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To foster an attitude of environmental responsibility.

### Common Essential Learnings Foundational Objectives

- To become familiar with terminology that describes the types of jobs associated with the production and transmission of electricity and with electrical safety. (COM)
- To demonstrate an ability to research information by using Internet sources and print material, evaluate the information for relevance and accuracy and communicate or present it effectively. (COM, TL, CCT)

| Learning Objectives | Notes |
|---|---|
| 11.1 To become familiar with the chief hazards and risks faced by workers in the electrical industry and with safety regulations, procedures, equipment and personnel at local or regional electrical generation or transmission sites. | Companies in the electrical industry are very concerned about worker safety. Students could interview managers, safety officers and workers from local sites and offices and prepare reports on potential hazards, occupational heath and safety laws and regulations, enforced safety procedures and drills, safety and emergency equipment and training, ongoing safety programs and specialist training. Site tours would provide added depth.<br><br>The SaskPower website contains information on hazards and safety procedures. Students could explore worker and workplace safety more extensively in conjunction with research into specific job skills, either in this module or in Module 10. |
| 11.2 To investigate the potential environmental effects of electrical generation, transmission and distribution. | Students could do research or conduct interviews to determine the environmental issues that are of local or general concern. They could identify the major alterations to land and surface waters that result from hydroelectric dams, coal mines and cooling facilities. They could investigate probable wastes and by-products of various forms of electrical generation and assess the potential effect of these on the air, water, soil, fish and wildlife, wild and domestic plants, domestic animals and people. |

| Learning Objective | Notes |
|---|---|
| | Students could set up an experiment in which potted plants are exposed to varying concentrations of some of the waste products produced by local or regional generating facilities and compare concentrations that produce visible effects with the concentrations actually released by the industry.<br><br>Students could also explore the research into the possible effects on humans and wildlife of the electrical fields surrounding transmission lines, substations and even domestic appliances. |
| 11.3 To become familiar with the legislation in place to protect the environment and how it is applied in practice in the field of electrical generation and transmission. | Students could explore the Environment section of the SaskPower website and use the email contact provided, to explore this topic. |
| 11.4 To identify and assess the consequences of failure of one or more programs or controls, whether through accident or failure to follow established procedures. | Students could identify emergencies that might arise (e.g., ice storm, collapse of transmission tower or line, sabotage or accident at substation, control system failure) and the solutions in place for these emergencies, as well as the immediate and long-term effects. Students could investigate real emergencies and find out what happened. |
| 11.5 To compare the costs of increased generating capacity with costs of conservation strategies. | How does use of cheap incandescent light bulbs compare to compact fluorescent bulbs?<br><br>Are there ways to reduce large uses of electricity such as air conditioning?<br><br>Light emitting diodes (LED) are new technology with exciting potential to reduce electricity consumption. Students could research them on the world wide web. LEDs are cheap and experimenting with them is fun. |
| 11.6 To be able to discuss the economic and social impact, both positive and negative, of local electrical generation or transmission facilities on the community, families and individuals. | Students could do research, conduct interviews, or simply brainstorm to assess how the local industry affects public services, housing, schools, construction, food services, shopping, recreation, etc. They could also be encouraged to examine the social effects of a fluctuating or transient population during construction and the effects of varying work schedules and seasonal or cyclical employment on the quality of life for individuals and families.<br><br>Students could participate in a “Town Hall Meeting” to discuss the pros and cons of local industry introduction or expansion. A hypothetical situation could be set up with each student or groups of students representing a community organization that either is for or against the proposed development. Students would discuss/argue as to the benefits or detriments of the project. A student “Mayor” could chair the meeting, or a community leader could be invited to preside. See also L.O. 10.8. |

# Module 12: Uranium - Formation, Location and Exploration (Optional)

**Suggested time:** 6-10 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will become familiar with the properties of uranium, the geological processes that led to the formation of uranium mineral deposits and the processes by which these deposits are located and assessed for commercial potential. When deciding whether to include Module 12 (and subsequent modules in this unit) in the program and if so, the degree of detail to be expected, the teacher may wish to assess student familiarity especially with Core Unit A-3 (Uranium) in the *Science 10* curriculum and also with Unit IV (Atoms and Elements) in the *Chemistry 20* curriculum and Unit IV (Nuclear Physics) in the *Physics 30* curriculum. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.
- To demonstrate knowledge of the natural processes underlying the formation of mineral, coal and hydrocarbon deposits.
- To understand the geological and geophysical principles underlying the process of resource exploration.
- To become familiar with some of the history of Saskatchewan's resource industries.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.

**Common Essential Learnings Foundational Objectives**
- To use correct terminology in discussing concepts and processes. (COM)
- To develop facility with the large numbers involved in geologic time measurement, including dating based on radioactive decay. (NUM)
- To engage in problem-solving simulations. (CCT, NUM)
- To develop an understanding, using uranium as the example, of how knowledge and technology is created, evaluated, refined and changed. (CCT, TL)

| Learning Objectives | Notes |
|---|---|
| 12.1 To describe key chemical and physical properties of the element uranium and pitchblende its major ore and explain the essentials of radioactive decay. | The school's physics department or local commercial facilities may have access to radiation detectors such as a Geiger counter and be prepared to demonstrate them to students. Students should not, however, be exposed to pitchblende under any circumstances. Other, safer sources of radioactivity may be substituted.<br><br>Students should be able to distinguish between "radiation" and "radioactivity", should understand the significance of half-life in assessing the radioactivity of a substance and should recognize the characteristics and relative hazards of the various types of radiation resulting from the decay of specific radioisotopes. Students could construct and demonstrate atomic models of radioisotopes and the process of radioactive decay.<br><br>Students could begin a glossary related to uranium and uranium mining and processing and continue it through the remaining modules in this Unit. |

| | Learning Objectives | Notes |
|---|---|---|
| 12.2 | To describe the conventional geological explanation for the presence of uranium deposits in Saskatchewan's Athabasca Basin. | Essentials include the upwelling of uranium from the earth's mantle through volcanic activity, the leaching of uranium from volcanic rock and the deposition, in the form of pitchblende, between the sandstone overburden and the granitic base rock at various locations within the Athabasca basin. The evolution of the Carswell Structure as a probable product of meteorite impact would make an interesting enrichment topic.<br><br>From their work in Module 3, students should be able to attach some probable geologic time estimates to the various geological events and processes.<br><br>If they have not already done so in Module 1, students could draw the Athabasca Basin on a map of Saskatchewan and then locate the present uranium mines on the map. |
| 12.3 | To outline major events in the history of uranium exploration and mining in Saskatchewan and some of the social changes that have taken place as a result of uranium mining. | Students could draw a time line chart of the history of nuclear energy and the uranium industry in particular.<br><br>Uranium City and Elliot Lake are two good examples of what happens to company towns when the ore deposits are mined out. The major uranium companies now have mining camps where the miners either drive or fly in and work one week and return home for one week. The difference in settlement pattern has major effects on family, personal lifestyles, numbers of hours of work, infrastructure required to support a town, etc. In the past, most mines could be profitably mined for 30 to 40 years. Now, most mines have a life span of only 20 years before they are mined out. As mining technology becomes more sophisticated and efficient, the time a mine remains open decreases. |
| 12.4 | To describe and illustrate current technologies in uranium exploration. | Some of the modern day techniques for detecting uranium deposits include geological mapping, boulder chasing, electromagnetic surveying, geophysical surveying, aerial mapping and core sampling. These are followed by assays, estimates of grade and tonnage and feasibility studies to determine if a mine is economically viable.<br><br>To simulate some of these techniques, students could be presented with a sandbox in which various coins are buried. They could devise and test ways of finding where the coins are located. |

| Learning Objectives | | Notes |
|---|---|---|
| 12.5 | To explore some economic considerations involved in prospecting and developing uranium deposits. | An activity that could bring together key concepts of the geology, prospecting, core identification and feasibility assessment is as follows: cut a piece of quarter-inch plywood or wallboard into eight 1x3-foot pieces. Stack the pieces to represent a map of Saskatchewan. Identify where you think the Athabasca Basin would be and place small bits of thin ferrous metal sheeting (e.g., "tin can" metal) in different sections of the area (do not overdo it.) Clamp the pieces and bring a hand (or electric) drill with a 1/16$^{th}$ inch drill bit. Have students devise and employ methods of detection, then charge them a fee to drill. If they find a piece of metal in their drill bit, they can take a share of the pot, or offer their plot for sale to other players. At the end of the lesson, expose the layers to see how close students came to the ore deposits and how big and how deep the deposits are. Discuss the implications for development of a mine.<br><br>McLean Lake mine and mill complex cost Cogema Resources over $3 billion as an initial investment up to 1997. While they were able to mine one ore deposit, they were not able to process the ore because of environmental hearings and assessments. The mill began processing the ore in the fall of 2000. The ore deposit from Sue Mine A produced $1 billion in profit. With the production of other mines in the area, Cogema will realize profit from its initial investment in the near future. |

## Module 13: Uranium - Production and Processing (Optional)

**Suggested time:** 8-12 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
This module introduces students to uranium mining and milling operations.

**Foundational Objectives**
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To demonstrate knowledge of the diversity and the economic, social and environmental significance, of Saskatchewan energy and mining industries.
- To examine the social impact of industries involved in resource exploration, production, transport and processing.
- To become familiar with the technology of the energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To employ correct terminology in describing uranium mining and milling. (COM)
- To collect data through use of interactive websites and virtual tours. (TL)
- To employ teamwork in simulating real life mining and milling situations and problems. (CCT, TL, PSVS)

| Learning Objectives | Notes |
|---|---|
| 13.1 To compare and contrast the two major types of uranium mines. | Students should know that uranium is mined either by open pit or by underground technology, depending on the depth of the ore body. They should explore the advantages of each method. Points of comparison could include labour costs, required machinery, safety hazards, ventilation, weather, supplies and equipment and removal of debris. Cost estimates around maintenance, repairs, fuel costs and electricity can be obtained from the offices of either Cogema or Cameco in La Ronge.<br><br>Students can take a virtual tour of a Cogema mine in Saskatchewan on the Keewatin Career Development Corporation website. The bibliography contains the address of the site.<br><br>Students could continue to add to a glossary of terms, if they began one in Module 12. |
| 13.2 To identify the main technological challenges in uranium mining and describe some of the major changes in mining technology over the past 50 years. | Students will be aware of two key requirements to accessing the ore – removing or bypassing the overburden as cheaply as possible and removing the ground water.<br><br>Students should know that technology has changed mining considerably. Until 1975 the mines were labour intensive. INCO, the largest nickel producer in the world, went from a labour force of over 25,000 in 1970 to under 9,000 in the year 2000 while increasing the amount of nickel it produced. The technology has become more sophisticated, with workers requiring more education and training; for example, the person running the McLean Lake mining operation has a doctoral degree in chemical engineering. |

| Learning Objectives | Notes |
|---|---|
| | Exposure to radiation remains the number one safety concern in uranium mining. The Cigar Lake Mine has such high levels of radiation that people cannot be exposed to the ore. Robotics engineering has made it unnecessary for humans to be near the face of the ore body.<br><br>Students could construct a model of one of the two mine types and if desired could conduct in a number of science-engineering projects, such as building machinery or using remote-controlled robotic toys to simulate a mining environment. |
| 13.3 To explore factors affecting the cost of opening and operating a mine. | Students should be aware of the costs involved in opening a mine. Locating the ore body involves millions of dollars of expenditure, with the possibility of no return. Infrastructure costs (technical needs, knowledge needs, transportation systems, etc.) usually run into the billions of dollars. Because one company usually cannot afford to open a mine by itself, partnerships with other companies help minimize the liability.<br><br>Students could work on a number of cost related problems facing mine supervisors. For example, is it cheaper to buy a new scoop tram or rebuild an old one? Costs of materials and running operations can be obtained from the Cogema office in La Ronge.<br><br>A comparison of the start up costs, potential profit and risks of a business familiar to students, such as farming or a retail store, could be done.<br><br>Students working in groups could modify the game of Monopoly so that it reflects the mining reality for northern Saskatchewan. |
| 13.4 To describe and model the basic processes involved in a milling operation and to examine some ongoing mill operating issues. | Students can take a virtual tour of a Cogema mill in Saskatchewan on the Keewatin Career Development Corporation website.<br><br>Students will understand the process to extract uranium from the ore through a series of steps – crushing, dissolving the uranium into a solution, precipitating the uranium from solution, drying the uranium and getting rid of the waste.<br><br>To simulate the process in simple experimental form, students could try to extract 100% salt from a known sand-salt mixture. Or they could try a more complex set of simulations, as follows:<br><br>Students could try to solve a problem that occurs in the first phase of the milling process: grinding. In each group there will be an operator, a quality control person, an engineer and a safety patrol. The students' job is to evaluate how a sugar cube can be crushed using different resources (a bag of marbles, a rolling pin, mortar and pestle, large weights, e.g., someone's foot). The evaluation should take into consideration the different perspectives offered by each group member. |

**Learning Objectives** | **Notes**

Students, working in the same "specialist" teams, could try to solve a problem that occurs in the second (slurry) and third (precipitate) phases of the milling process. Their job is to evaluate how to take the crushed sugar from experiment 1, add it to an oil/water solution and separate the two liquids. In this case the oil represents sulphuric acid. Again, stress the need to retrieve 100% of the uranium (sugar). The oil is sent to the tailings pond.

Finally, the same teams could solve a problem that occurs in the fourth phase (drying) of the milling process. The students' job is to evaluate which process - heating or evaporation - works the best in retrieving the sugar.

In simulating mill operation issues, students could try, for example, to solve air and water quality problems in the mill. The usual teams of "specialists" could evaluate how to purify a sample of dirty air or water and how to dispose of the waste materials. As well, students could work on a number of cost-related problems facing mill supervisors. For example, is it cheaper to hire a new worker or have workers work overtime? Costs of materials and running operations can be obtained from the Cogema office in La Ronge.

## Module 14: Uranium - Refinement, Distribution and Uses (Optional)

**Suggested time:** 8-12 hours **Level:** Introductory
**Prerequisite:** Module 13

**Module Overview**
Students will learn about nuclear chain reactions. They will explore how uranium is purified to obtain a fissionable product and the various uses to which this product has been put. They will explore the global uranium marketplace. Finally they will study nuclear power generation based on the CANDU reactor and assess its potential in comparison to other sources of electricity.

**Foundational Objectives**
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.

**Common Essential Learnings Foundational Objectives**
- To use correct terminology in describing uranium processing and nuclear energy. (COM)
- To research nuclear technology and nuclear issues using the Internet. (COM, TL)
- To use statistics and economic data in exploring aspects of the nuclear industry. (NUM)
- To examine and present arguments on both sides of controversial issues. (CCT)

| Learning Objectives | Notes |
|---|---|
| 14.1 To explain the nature of a chain reaction, in relation to the two common isotopes of uranium. | Students should be aware that U-235, the less common of the two isotopes (0.7%, by mass, of natural uranium), is less stable and if sufficiently concentrated and in sufficient mass will undergo a chain reaction. U-238, by contrast, is quite stable and difficult to coax into a chain reaction. The goal of refining is to separate and purify the U-235.<br><br>Students could illustrate the contrast by standing dominoes in different configurations and showing what happens when the first one is tipped.<br><br>The teacher may wish to introduce and explain briefly the process of nuclear fusion, as distinct from fission, because students often confuse the two.<br><br>Students could continue to develop their glossaries. |
| 14.2 To describe the route followed and the changes undergone, by the concentrated uranium ore (yellowcake) from the processing mill to its final market destination. | Students should be aware that yellowcake is not a usable form of uranium and understand why it needs refinement. In Canada the yellowcake is refined at the Blind River plant in Ontario and then goes on to the Port Hope plant for final processing. Alternatively, it may go to plants in the US, France, or Britain. The bulk of yellowcake is processed outside of Canada.<br><br>Students could prepare flow charts illustrating the refining and processing of uranium ore. |

| Learning Objectives | Notes |
|---|---|
| | Both Cogema and Cameco have produced videos that detail the production, refinement and use of uranium. The videos can be purchased from the head offices of both companies in Saskatoon. |
| 14.3 To summarize the global uranium marketplace -- producers, processors and end users -- and identify Canada's place in the marketplace. | Students could research where uranium is presently mined around the world and identify the corporations that own the mines. As well, students could research where the refineries and enrichment plants are located and identify the corporations that own them. Presently, corporations control all aspects of bringing U-235 to market. Foreign governments can purchase U-235 for domestic power reactors, but they may also be able to divert a certain portion of U-235 for military purposes. Students should be aware of uranium’s military use as well as its role in electrical generation.<br><br>Students could debate the question of who should control the marketing of Canada's U-235. |
| 14.4 To interpret the economics of the uranium industry in terms of capital investment, profit/loss, infrastructure, headquarters, stock prices, government intervention and regulation, etc. | Students could chart the value of both Cameco and Cogema shares for a month, as well as research their long-term price fluctuations, from stock market websites. In addition, students could research the history of amalgamations, buyouts, bailouts and bankruptcy actions in the industry. Many stock market simulations are available and could be used as a supplement.<br><br>To identify the corporate giants and how they work with governments, students could undertake some of the activities on pages 117-128 of the *Saskatchewan Resource Series: Uranium* (1990). |
| 14.5 To explore Canada’s historic role in the development and application of nuclear energy, including both commercial and military uses and our country's current research and development initiatives in the nuclear industry. | Students could begin by exploring the history of early nuclear weapons development, including Canada's central role. Students should have a basic understanding of how and why a fission bomb works and how it differs from a fusion weapon.<br><br>Students should be familiar with Atomic Energy of Canada Ltd. and its efforts to market CANDU reactors throughout the world.<br><br>Students could research and report on commercial applications of nuclear energy in fields other than electrical generation, such as medicine and human heath, food processing, agriculture and industry. They could explore Saskatchewan's historic role in radiation-based cancer therapy. They could explore the uses of small research reactors such as the University of Saskatchewan's Slowpoke reactor. |

| Learning Objectives | Notes |
| --- | --- |
| 14.6 To describe how a CANDU nuclear reactor works and how a nuclear power plant converts nuclear energy to electrical energy. | Students should be able to apply the concept of controlled fission to the production of electricity in a power plant. Students could prepare scale drawings or construct a model of a typical nuclear generating facility based on CANDU reactor technology. |
| 14.7 To explore the pros and cons of nuclear power plants as compared to other types of electrical generation, particularly coal-fired thermal and hydroelectric. | Students could explore, in greater detail than in Module 4, the variety of social and environmental issues around this topic. A print source is the *Saskatchewan Resource Series: Uranium* (1990). |

## Module 15: Uranium - Workplace Safety, Environmental Safety and Careers (Optional)

**Suggested time:** 10-18 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore occupational and environmental safety standards for the uranium mining and processing industries and for nuclear power facilities. As well, students will investigate the social impact of the uranium industry, with emphasis on career and employment opportunities. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 12, 13 and 14 in a pure course.

**Foundational Objectives**
- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.
- To demonstrate knowledge of the diversity and the economic, social and environmental significance, of Saskatchewan energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To develop a critical appreciation of the standards of occupational health and safety within the industry. (CCT)
- To develop a critical appreciation of the environmental standards and regulations that apply to the industry. (CCT)
- To examine community concerns regarding the impact of uranium exploration, mining, milling, transport, refining and use as nuclear fuel. (PSVS, CCT, COM)
- To use the Internet in exploring career opportunities in the uranium and nuclear industries. (TL, IL)

| Learning Objectives | Notes |
|---|---|
| 15.1 To become familiar with the safety regulations, procedures, equipment and personnel at local or regional mining and milling sites. | Students could explore safety concerns in regard to operation of heavy equipment, handling of explosives and hazardous chemicals, internal and external exposure to radiation in the mine and mill.<br><br>Students could interview managers, safety officers, First Responder teams and workers from the uranium industry. They could prepare reports on potential hazards, occupational health and safety laws and regulations, enforced safety procedures and drills, safety and emergency equipment and training, ongoing safety programs and specialist training. Site tours would provide added depth.<br><br>Regular monitoring of the radiation levels at mines is done by the Occupational Health and Safety Branch of Saskatchewan Labour.<br><br>Students should be familiar with WHMIS (Workplace Hazardous Materials Information System). Students could apply their examination of WHMIS to hazardous chemicals in the home, particularly the kitchen and bathroom areas. |

| Learning Objectives | Notes |
|---|---|
| | Personal protection equipment worn in the mine and mill areas includes safety boots, coveralls, safety hats, hearing protection, safety glasses and radiation badges. Cogema is willing to supply a kit to interested teachers. |
| 15.2 To investigate the potential environmental effects of uranium exploration, mining, milling, transport, refining and use as nuclear fuel. | Students could research or conduct interviews to determine the environmental issues that are of local or general concern. They could identify wastes and by-products of mining and milling and investigate the potential effect of these on surface water and the water table. They could examine the dispersal by wind of escaping gases and dust and the potential impact of these on the air, water, soil, plants, animals and people.<br><br>Although Saskatchewan has no nuclear power installations, students might wish to examine the environmental issues that arise in parts of Canada where nuclear power plants operate, Ontario and New Brunswick. |
| 15.3 To be aware of the waste products from nuclear power generation, the hazards they present and methods of transportation and storage of the materials. | Students could investigate the differences between the waste produced by CANDU reactors and other types of reactors. The half life of the material, potential hazards to the environment, amount of material and where it is currently held should be researched.<br><br>Atomic Energy of Canada did a substantial amount of research into long-term storage methods. A long-term storage site is being developed at Yucca Mountain in Nevada, USA. |
| 15.4 To become familiar with the legislation in place to protect the environment and how it is applied in practice. | Before a mine can open or shut down, the company must have completed an impact assessment and report, including reclamation procedures and have had it accepted by government regulators. As well as examining samples of these reports, students might explore the financial impact of environmental legislation on the costs of bringing a mine to production and decommissioning it when the ore body is exhausted.<br><br>Students should also research and report on the nature and frequency of tests done to monitor the environment and the standards of the mine, mill, or other facility.<br><br>If the teacher wishes to go into greater depth, films and notes are available on public hearings conducted when Rabbit Lake and McArthur Lake mines were proposed. Cluff Lake mine was slated for closure in the year 2000; students can write to Cogema Mines in La Ronge to learn why it is still open. |

| Learning Objectives | Notes |
|---|---|
| 15.5 To identify and assess the consequences of failure of one or more waste management programs or controls, whether through accident or failure to follow established procedures. | Students could identify emergencies that might arise (e.g. explosion or fire, radon gas concentration, accidental radiation exposure, dike or tailings pond failure, leaking storage vessel, transport truck accident) and the solutions in place for these emergencies, as well as the immediate and long-term effects. Students could investigate real emergencies, such as a number of potentially serious incidents in the 1950s and 1960s at Chalk River and several U.S facilities and find out what happened.<br><br>If nuclear power generation facilities are included in the study, the study of significant accidents such as Three Mile Island or Chernobyl could provide a perspective for discussions and debates. |
| 15.6 To discuss the economic and social impact, both positive and negative, of uranium industries on the community, families and individuals. | Students could research, conduct interviews or simply brainstorm to assess how local industry affects public services, housing, schools, construction, food services, shopping, recreation, etc. They might also be encouraged to examine the social effects of a fluctuating or transient population and the effects of varying work schedules and seasonal or cyclical employment on the quality of life for individuals and families. Because all Saskatchewan uranium mining is in the north, the effects on local aboriginal populations and traditional economies is an important issue for investigation.<br><br>Students could participate in a "Town Hall Meeting" to discuss the pros and cons of local industry introduction or expansion. A hypothetical situation could be set up with each student or groups of students representing a community organization that either is for or against the proposed development. Students would discuss/argue as to the benefits or detriments of the project. A student "Mayor" could chair the meeting, or a community leader could be invited to preside. Interest groups might include on-site managers (environmental detection group, mine superintendent), federal and provincial authorities, environmental groups, First Nations groups and members of the general public. Areas of local concern could include a possible failure in the waste management system at the mine site, the disposal and storage of waste (tailings), contamination of the air, land, surface water, groundwater or food chain with milling by-products, disruption of the ecosystem in the mine area, decommissioning a mine or mill. If nuclear power plants are included, issues might include disposal and storage of radioactive waste (used fuel bundles), decommissioning of a reactor, or release of radioactive material into the environment by a nuclear reactor. |

| Learning Objectives | Notes |
| --- | --- |
| 15.7 To demonstrate familiarity with employment opportunities and careers in the uranium industry. | Students could develop a list of careers or jobs, either local or throughout the industry and categorize each as professional/non-professional, technical/non-technical, permanent/seasonal, full time/part time. Gender equity in job opportunities could be explored. To realize that different careers require different skills, students could research the required skills for different careers and report to the class.<br><br>Students could juxtapose job descriptions and responsibilities with educational levels and training required. General categories might include administration, management, scientific positions, mill workers and blue-collar workers, recreational workers, mine support staff. Personnel lists, along with general wages and other job parameters, can be obtained from Cogema Resources in La Ronge and Cameco Resources in Saskatoon.<br><br>To appreciate the role of northern people in the mining sector, students can visit the Keewatin Career Development Corporation website and work through Lesson 3b.<br><br>Students could prepare hypothetical tax returns for selected employees, to get an idea of pay and deductions.<br><br>Students could be introduced to trade unions, bargaining, labour-management relations and issues around non-union contracting, if the teacher sees these as relevant and/or appropriate topics.<br><br>Students could prepare a detailed report on one specific career in the industry after research, interviews and, where possible, work study or job shadowing. |

## Module 16: Coal - Formation, Location and Exploration (Optional)

**Suggested time:** 8-12 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn about the formation of coal, methods of exploration for coal deposits and the properties of coal, with particular reference to Saskatchewan coal fields. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To demonstrate knowledge of Saskatchewan's landforms and natural environments and their relation to renewable and nonrenewable resources.
- To demonstrate knowledge of the natural processes underlying the formation of mineral, coal and hydrocarbon deposits.
- To understand the geological and geophysical principles underlying the process of resource exploration.

**Common Essential Learnings Foundational Objectives**
- To use correct terminology in discussing coal geology and exploration. (COM)
- To prepare visual representations of comparative data. (NUM, COM, CCT)
- To explain the principles behind selected exploration technologies. (COM)

| Learning Objectives | Notes |
|---|---|
| 16.1 To be familiar with generally accepted explanations of how, when and where coal was formed. | Students should review the location of Saskatchewan coal deposits from Module 1 and the general geological history from Module 3. Saskatchewan coal and Western Canadian coal in general, is geologically much younger than the Paleozoic coal of eastern Canada and U.S. Students should become familiar with the geology of the Ravenscrag Formation. They could then research when and how Saskatchewan's coal is thought to have formed, the flora and fauna of the period and the role of climatic change in the formation of coal.<br><br>Students could perform simple experiments to discover the effects of pressure and heat (in the absence of oxygen) on various plant materials.<br><br>Students could explore the fossil content of coal samples such as coal balls (available from science supply outlets.)<br><br>Students could begin a glossary of terms related to coal and coal mining. |
| 16.2 To name and compare the different types of coal. | Students should become familiar with the four classes of coal, i.e. anthracite, bituminous, sub-bituminous and lignite. The comparison should include formation, chemical content, location and specific uses. The class could obtain samples and compare them, using such criteria as colour, hardness, texture, energy content and common uses.<br><br>Students could burn measured amounts of some kinds of coal (especially local lignite) and perform calorimetric estimates of energy content. They could compare the mass of ash with the original mass before burning, to determine mineral content. They could try to devise and test methods of estimating the water content of a coal sample (approx. 40% in the case of local lignite.) |

| Learning Objectives | | Notes |
|---|---|---|
| 16.3 | To identify the locations, types of deposits and estimated reserves of coal in Canada and make comparisons with other countries worldwide. | Students could make maps showing the location of deposits in Canada and devise a notation or key to indicate the classification, existing reserves and use of the coal mined in each of these areas. Functioning and non-functioning mine sites could be included, as well as the type of mining (surface or underground.)<br><br>Students could discuss and compare the size, shape, depth and extent of deposits in the mountain regions, the prairies, the Maritimes and the Yukon. This information will be useful when the various methods of coal extraction are studied.<br><br>Using a world map, students could plot the *major* locations of coal deposits and the extent of the reserves in each of these countries. Students could create charts comparing the estimated reserves and the actual production of coal worldwide. |
| 16.4 | To describe technologies used in coal exploration. | Exploration techniques include 2 dimensional and 3 dimensional seismic surveys, detailed gravity measurements and geophysical logging of fully cored drill holes. As well, space technology, such as Global Positioning Systems (GPS), is used in coal surveying and mapping, helping reduce mining costs by eliminating the need for difficult overland survey work.<br><br>Students should become familiar with the following terms in the context of coal exploration:<br>• two-dimensional seismic line<br>• three-dimensional seismic survey<br>• gravity measurement<br>• geophysical logging<br>• core sample<br>• global positioning system (GPS)<br>• surveying<br>• mapping.<br><br>Students could also explore magnetometers, electrical methods such as self-potential, induced polarization and resistivity, as well as radiometric methods and geochemistry. A resource person, such as an exploration geologist or geophysicist, would be beneficial for this section. |

## Module 17: Coal - Mining Methods, Production and Uses (Optional)

**Suggested time:** 5-8 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will become familiar with the various methods of mining coal, with emphasis on the methods used in Saskatchewan, the uses of coal and the changes in mining techniques through the decades. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Module 16 in a pure course.

**Foundational Objectives**
- To become familiar with the history of Saskatchewan's resource industries.
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.

**Common Essential Learnings Foundational Objectives**
- To conduct research using the Internet and other print and non-print resources. (TL)
- To use correct terminology in discussing coal mining, processing and uses. (COM)

| Learning Objectives | Notes |
|---|---|
| 17.1 To identify and compare the different methods used in coal mining. | Students should be able to describe strip (surface) mining, open pit mining and underground mining (including the room and pillar concept).<br><br>Students should understand the reasons for using a particular method. They should be familiar with mining terms such as dragline, hauler, stockpile, coal seam, overburden, spoil pile, mule, longwall mining, room and pillar mining, drift, slope, shaft, continuous miner, short wall and conventional mining.<br><br>Students could construct or draw models of each type of mine.<br><br>Students should view the video "Coal: Fueling the Future " produced by the Coal Association of Canada.<br><br>Students could continue to add to the glossaries they began in Module 16. |
| 17.2 To describe methods of distribution of coal, beginning at the mine site. | Students should describe the transportation of coal from the coal seam to the surface to the stockpile in underground mines and compare this with the transportation from open pit and surface mines. Students should become familiar with and understand, the terminology. |

| Learning Objectives | Notes |
| --- | --- |
| 17.3 To examine the history of coal mining in Saskatchewan. | Students can research this topic by accessing coal company websites looking for current and historical information about Saskatchewan coal mining. They could compare the current mining procedures with those of the past. |
| 17.4 To understand the importance of reclamation as part of the mining process. | This Learning Objective may be deferred to, or combined with, Module 18, if the teacher chooses.<br><br>Students could access photos of past and present Saskatchewan mine sites to discover the significant part reclamation plays in modern mining. Some questions they might try to answer include the following:<br><br>What does "reclamation" mean?<br>Why is it done?<br>How is it monitored?<br>What is the responsibility of the mining company?<br>What guarantees are in place to insure the mining company lives up to its reclamation responsibilities?<br><br>Students can contact Saskatchewan Energy and Mines to access up-to-date regulations. |
| 17.5 To understand the significance of coal in the production of electricity in Saskatchewan and elsewhere. | Students could construct graphs or other visual representations of the role of coal in electrical generation in Canada and worldwide.<br><br>Students could take a field trip to a major power station in southern Saskatchewan. In any case, students should be familiar with the steps involved in power production, from the stockpiling of coal through to the transmission of electricity from the substation to the community and to industry. Information and charts are available from SaskPower upon request and at their website. |
| 17.6 To be familiar with the many uses of coal. | Students could create a list of the uses of coal and the many household and industrial products that use coal either directly, or indirectly, through coal by-products.<br><br>Students could access websites listed in the bibliography. An interesting project could be to research and list all the products in the home that contain a coal by-product. |

## Module 18: Coal - Workplace Safety, Environmental Safety and Careers (Optional)

**Suggested time:** 10-18 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore occupational and environmental safety standards for the coal mining industry and (if the unit on Electricity has not been included in the program) for coal-powered electrical generating facilities. As well, students will investigate the social impact of the coal industry, with emphasis on career and employment opportunities. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Module 17 in a pure course.

**Foundational Objectives**
- To demonstrate knowledge of the diversity and the economic, social and environmental significance, of Saskatchewan energy and mining industries.
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.
- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.

**Common Essential Learnings Foundational Objectives**
- To develop a critical appreciation of the standards of occupational health and safety within the industry. (CCT)
- To develop a critical appreciation of the environmental standards and regulations that apply to the industry. (CCT)
- To examine community concerns regarding the impact of coal exploration, mining, transport and use as fuel. (PSVS, CCT, COM)
- To use the Internet in exploring career opportunities in the coal mining and coal-fueled power industries. (TL, IL)

| Learning Objectives | Notes |
|---|---|
| 18.1 To become familiar with the safety regulations, procedures, equipment and personnel at local or regional mining and power generation sites. | Students could explore safety concerns in regard to operation of heavy equipment, handling of explosives and hazardous chemicals and exposure to dust and gases.<br><br>Students could interview managers, safety officers, First Responder teams and workers from the coal mining industry. They could prepare reports on potential hazards, occupational heath and safety laws and regulations, enforced safety procedures and drills, safety and emergency equipment and training, ongoing safety programs and specialist training. Site tours would provide added depth.<br><br>Students could examine some of the problems faced by early coal miners and how these were handled. The testing of air quality and personal safety equipment in the early mines would be very interesting information. Group discussions about the control the mine owners had over miners in the past compared to today would give the students a new perspective on modern mining. Students could also research coal mine safety measures in other parts of Canada, the USA and third world countries. |

| Learning Objectives | Notes |
|---|---|
| | Regular monitoring of the working environment at mines is done by the Occupational Health and Safety Branch of Sask. Labour. The teacher may wish to use some time to lead students through the Ready for Work program produced by the Prevention Services Branch of Sask. Labour. The program helps students explore Occupational Health and Safety regulations and procedures, Workplace Hazardous Materials Information System (WHMIS) and the provisions of the Labour Standards Act, among other topics. |
| 18.2 To investigate the potential environmental effects of coal exploration, mining, transport and use as fuel. | Students could research or conduct interviews to determine the environmental issues that are of local or general concern. They could identify wastes and by-products of mining, processing and burning and investigate the potential effect of these on surface water and the water table. They could examine the dispersal by wind of escaping gases and dust and the potential impact of these on the air, water, soil, plants, animals and people.<br><br>The evidence that carbon dioxide gas produced by coal burning is a contributor to the build up of greenhouse gases and climate change is becoming more conclusive. Climate change research and discussion or debate could be pursued.<br><br>Students could pursue their investigations into the topic of reclamation, introduced in Module 17. |
| 18.3 To become familiar with the legislation in place to protect the environment and how it is applied in practice. | Before a mine can open or shut down, the company must have completed an impact assessment and report, including reclamation procedures and have had it accepted by government regulators. As well as examining samples of these reports, students might explore the financial impact of environmental legislation on the costs of bringing a mine to production.<br><br>Students should also research and report on the nature and frequency of tests done to monitor the environment and the standards of the mine or power plant. |
| 18.4 To identify and assess the consequences of failure of one or more environmental or worker safety programs or controls, whether through accident or failure to follow established procedures. | Students could identify emergencies that might arise (e.g. explosion, fire, dragline collapse, transport accident, electrical accident) and the solutions in place for these emergencies, as well as the immediate and long-term effects. Students could investigate real emergencies and find out what happened. |

| Learning Objectives | Notes |
|---|---|
| 18.5 To be able to discuss the economic and social impact, both positive and negative, of the coal mining industry on the community, families and individuals. | Students could research, conduct interviews or simply brainstorm to assess how local industry affects public services, housing, schools, construction, food services, shopping, recreation, etc. They might also be encouraged to examine the social effects of a transient worker population and the effects of varying work schedules and seasonal or cyclical employment on the quality of life for individuals and families.<br><br>Students could participate in a “Town Hall Meeting” to discuss the pros and cons of local industry introduction or expansion. A hypothetical situation could be set up with each student or groups of students representing a community organization that either is for or against the proposed development. Students would discuss/argue as to the benefits or detriments of the project. A student “Mayor” could chair the meeting, or a community leader could be invited to preside. Interest groups might include on-site managers (environmental officer, mine superintendent), federal and provincial authorities, environmental groups, First Nations groups and members of the general public. Areas of local concern could include environmental degradation at the mine site, contamination of the air, land, surface water, groundwater or food chain with mining by-products, disruption of the ecosystem in the mine area, potential for stockpile fire, decommissioning a mine and reclamation. If power plants are included, additional issues might include airborne pollutants, disposal or storage of solid waste (ash), damming of local waterways to create a water supply and the potential hazards and inconveniences of transmission towers, power lines and substations. |
| 18.6 To demonstrate familiarity with employment opportunities and careers in the coal industry. | Students could develop a list of careers or jobs and categorize each as professional/non-professional, technical/non-technical, permanent/seasonal, full time/part time. Gender equity in job opportunities could be explored.<br><br>A good place to start might be a web search for "coal mining careers". This could be followed by interviews with local mine management, or a guided tour of a coal mining operation.<br><br>Students could juxtapose job descriptions and responsibilities with educational levels and training required. General categories might include administration, management, scientific positions, miners and blue-collar workers, support staff.<br><br>Students could prepare hypothetical tax returns for selected employees, to get an idea of pay and deductions.<br><br>Students could be introduced to trade unions, bargaining, labour-management relations and issues around non-union contracting, if the teacher sees these as relevant and/or appropriate topics.<br><br>Students could prepare a detailed report on one specific career in the industry after research, interviews and, where possible, work study or job shadowing. |

## Module 19: Alternate Energy Sources - Heat (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore heat energy sources other than fossil fuels, specifically solar, biomass and geothermal and their potential uses in Saskatchewan and elsewhere. They will also examine energy conservation technology as it applies to heating. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.
- To examine and assess the impact of, conventional and alternative energy production and energy conservation technologies in Saskatchewan.
- To demonstrate knowledge of alternative energy resources that are, or could be, used in Saskatchewan.
- To assess the need for and economic impact of, alternative energy resources in Saskatchewan.

**Common Essential Learnings Foundational Objectives**
- To use appropriate terminology in describing heat and heating technologies. (COM)
- To demonstrate an ability to research information using Internet sources and print material. (COM, TL)
- To design and build a model of alternative heating technology. (TL, CCT)

| Learning Objective | Notes |
|---|---|
| 19.1 To understand the nature of heat energy and the relationship between heat and other forms of energy. | Students could review some of the activities done in Module 1 and/or view the video from the kit: *Saskatchewan Resource Series: Energy and the Environment* (1989).<br><br>Students could begin a glossary of terms related to heat energy and alternative energy sources generally. |
| 19.2 To distinguish between heat and temperature and be familiar with the measurement of each. | Students should become familiar with calories and joules as energy units and with the Celsius and Kelvin temperature scales. Which contains more heat, a litre of water at 100°C or a megalitre of water at 0°C? |
| 19.3 To identify sources of energy currently used in space heating and water heating in Saskatchewan. | Students should understand that Canadians use more energy per capita than any other nation in the world.<br><br>Students could start with their own school, home and community in compiling a list.<br><br>Comparisons could be made among sizes and types of buildings being heated and the purpose for heating in each case. |
| 19.4 To make comparisons among fuel types regarding cost, convenience and fuel efficiency. | Estimates for a specific heating situation could be made comparing amounts of fuel used, unit cost, cost per unit of space heated. |

| Learning Objective | Notes |
|---|---|
| 19.5 To become familiar with solar heating technologies, both passive and active. | Solar clothes dryers have been widely employed for many years in Saskatchewan. So have greenhouses. As well, students could investigate traditional uses of solar heat in food preparation and preservation, for both humans and livestock and modern uses such as solar grain dryers.<br><br>Solar energy may be stored in one of two ways: raising the temperature of substances such as concrete or water (heat capacity storage), or using the heat to change the state of a substance -- melting a solid or vaporizing a liquid.<br><br>Students could investigate the design and placement of windows and heat sinks in passive home heating. They should compare a variety of substances as heat sinks, as well as studying the efficiency of various window designs and components. A parallel could be drawn between entrapment of energy by glass in a heating context and the Greenhouse Effect.<br><br>Students could research, design and build an active or passive solar heating system.<br><br>Students could compare the effectiveness and efficiency of air, water and other substances as the collecting medium. |
| 19.6 To explore technologies for concentrating solar energy. | Solar ovens, solar furnaces, solar power plants all use concentrating technology.<br><br>Students could research, design, build and demonstrate solar cookers. A solar cooking fair could be held, possibly in conjunction with one of the Food Studies modules. |
| 19.7 To investigate the advantages and disadvantages of solar heating and identify regions in Saskatchewan and Canada that have greatest potential for solar heating. | Students could use data on intensity and consistency of incoming solar radiation, as well as on length and severity of winters. Students could review the significance of heat in climate determination (see Climate Backgrounder) and determine the suitability of different locations for solar heating.<br><br>These data may also be useful in Module 20. |
| 19.8 To become familiar with the use of wood and other biomass as a source of heat. | Traditional uses of wood, straw, buffalo chips and animal fat as fuel for heating and cooking could be explored.<br><br>Students could investigate the burning of agricultural by-products and human garbage as potential heat sources.<br><br>Students could investigate biogas generation from livestock wastes. More information may be obtained from National Research Council and Saskatchewan Agriculture Food and Rural Revitalization, among others.<br><br>Students should be aware that biomass generates heat through decomposition processes as well as through combustion. |

| Learning Objective | Notes |
| --- | --- |
| 19.9 To become familiar with sources and uses of geothermal heat. | Hot springs and thermal pools have been used all over the world since ancient times. Students could investigate the use of hot springs in North America prior to 1492. Moose Jaw's Temple Gardens Mineral Spa is a modern Saskatchewan example. Students visiting it or other similar places could investigate while there and report to the class.<br><br>Students could investigate modern commercial uses of geothermal energy in places such as Iceland and New Zealand.<br><br>The University of Regina undertook an experimental geothermal heating project in the 1970s. Students might investigate the nature of this project and find out why it is no longer in operation.<br><br>Students could investigate the relationship between temperature and depth within the earth's crust and look for current attempts to exploit this in the context of heating. |
| 19.10 To assess the advantages of energy conservation in the context of heating. | Students should understand that conserving heat through insulation and other techniques furthers energy sustainability.<br><br>Students could estimate the costs of heating a home with different amounts of insulation over a 25-year period.<br><br>Students could compare product cost, installation cost, insulation efficiency and safety for various insulation materials.<br><br>Students could investigate ways in which building design and location affect heating costs.<br><br>Students could compare the cost and return on investment of various types of heating appliances (furnaces, water heaters, heat exchangers, etc.) |

## Module 20: Alternate Energy Sources - Electrical Generation (Optional)

**Suggested time:** 10–15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore and assess the potential of wind, solar and other sources of electrical energy as supplements or alternatives to the thermal, gas turbine and hydroelectric installations that provide almost all of Saskatchewan's commercial electricity. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Mdules 1, 2, 3, 4 and 9 in a pure course.

**Foundational Objectives**
- To foster an attitude of environmental responsibility.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.
- To examine and assess the impact of, conventional and alternative energy production and energy conservation technologies in Saskatchewan.
- To demonstrate knowledge of alternative energy resources that are, or could be, used in Saskatchewan.
- To assess the need for and economic impact of, alternative energy resources in Saskatchewan.

**Common Essential Learnings Foundational Objectives**
- To use appropriate terminology in describing technology and its operation. (COM)
- To demonstrate an ability to research information by using Internet sources and print material. (TL)
- To design, build and test a model of one or more alternative electrical generation methods. (NUM, CCT, TL)

| Learning Objective | Notes |
|---|---|
| 20.1 To explore the historical uses of wind energy in human enterprise. | Students could identify transportation, water pumping (from wells and dugouts, as well as in large scale land drainage, e.g., Holland) and electrical generation. |
| 20.2 To explore the various technologies developed worldwide to harness wind energy in generating electricity and identify regions in Saskatchewan and Canada that have potential for wind electrical generation. | Refer to L.O. 2.1.<br><br>Students could use data on wind consistency and strength to assess appropriate technologies for local conditions.<br><br>Students could construct a working model of a wind-powered electrical generator and design and carry out tests of its energy output and efficiency.<br><br>Students could investigate current Saskatchewan wind-powered electrical generation initiatives, such as the projects near Gull Lake. |
| 20.3 To assess the advantages and disadvantages of wind power as a source of electricity. | |
| 20.4 To learn how photocells are made and how they work. | Student will be familiar with the use of photocells in calculators, watches, security systems, street lights, etc. Nevertheless, the focus in this module should be on commercial solar power generation. |

| Learning Objective | Notes |
|---|---|
| 20.5 To identify regions in Saskatchewan and Canada with potential for solar electrical generation. | Students could use data on intensity and consistency of incoming solar radiation. If Module 19 has been completed, these data may already be available. |
| 20.6 To investigate examples of solar power use in Saskatchewan and elsewhere. | Some Saskatchewan examples include electric fences, electric signs, emergency communication technology, solar campground (in Prince Albert National Park.)<br><br>Students could construct a working model powered by a solar cell and design and carry out tests of its energy output and efficiency. |
| 20.7 To assess the advantages and disadvantages of solar power as a source of electricity. | |
| 20.8 To investigate examples of electrochemical generation and storage technology and assess the advantages and disadvantages of each. | This would include fuel cells and various types of wet and dry storage cells (batteries). |
| 20.9 To investigate and assess the potential of nuclear power generation. | If Module 14 is part of the program, this objective will have been covered there. If not, the teacher should refer to that module for a more detailed treatment of this objective. |
| 20.10 To investigate co-generation as a supplementary electrical power source. | SaskPower is involved in or considering several co-generation projects. Refer to the SaskPower website for details. |
| 20.11 To investigate small-scale stand-alone hydroelectric generation. | The Pelton turbine is one of several small-scale, high-efficiency generation devices popular in developing nations. A model could be constructed and tested. |

## Module 21: Alternate Energy Sources - Transportation (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore alternatives to gasoline or diesel for fuelling internal combustion engines, as well as looking at some alternative power sources. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To foster an attitude of environmental responsibility.
- To demonstrate knowledge of the methods of commercial energy production and distribution, with emphasis on those used in Saskatchewan.
- To examine and assess the impact of, conventional and alternative energy production and energy conservation technologies in Saskatchewan.
- To demonstrate knowledge of alternative energy resources that are, or could be, used in Saskatchewan.
- To assess the need for and economic impact of, alternative energy resources in Saskatchewan.

**Common Essential Learnings Foundational Objectives**
- To use appropriate terminology in describing fuel technologies. (COM)
- To demonstrate an ability to research information by using Internet sources and print material. (TL)

| | Learning Objective | Notes |
|---|---|---|
| 21.1 | To explain the basic principles underlying fuel cell technology. | Students will have been introduced to fuel cell applications in L.O. 20.8. Fuel cells use various fuels to generate electricity through non-combustible chemical reactions. They are basic to the commercial exploitation of a number of alternative fuels in the transportation industry. |
| 21.2 | To explore the potential uses and advantages and disadvantages, of hydrogen as a fuel. | Students should be familiar with the basic chemistry that underlies common methods of commercial hydrogen generation, including electrolysis of water and reaction of water with active metals and hydrocarbons. Laboratory demonstrations of some of these (under supervision) might be arranged with the chemistry teacher. |
| 21.3 | To explore the potential uses and advantages and disadvantages, of biogas as a fuel. | Production of methane by anaerobic decomposition of livestock waste and the subsequent use of the gas as a heat source, is probably the most familiar biogas application and has been considered in Module 19. Nevertheless, other potential biogas sources (e.g., municipal dumps) and applications can readily be discovered through Web searches. |
| 21.4 | To explore the potential uses, advantages and disadvantages and potential economic impact, of biodiesel as a fuel or fuel component. | In particular, production of biodiesel from Saskatchewan oilseed crops, as well as from some animal byproducts, could be examined. |

| Learning Objective | Notes |
|---|---|
| 21.5 To explore the potential uses, advantages and disadvantages and potential economic impact, of ethanol as a fuel or fuel component. | Fuel ethanol, also known as "gasohol" when mixed with gasoline, is made primarily from grains or other renewable agricultural and agro-forestry feedstocks. The Poundmaker Ethanol Plant in Lanigan is Saskatchewan's first working plant to produce ethanol for fuel. There have been other ethanol operations, but the product use was not compatible with transportation.<br><br>Have students research the Saskatchewan legislation on the introduction of ethanol fuel. Students could debate the legislation. |
| 21.6 To investigate methods by which gasoline engines can be converted to use propane or natural gas as fuel sources and the advantages and disadvantages of doing so. | If possible, students should examine a propane-fuelled vehicle, preferably under the supervision of a licensed mechanic and assess its pros and cons. |
| 21.7 To investigate the technology and the advantages and disadvantages, of electric-powered and gas-electric hybrid automobiles. | Electric automobiles have been around for over a century, so information is abundant. |

## Module 22: Potash - Formation, Location and Exploration (Optional)

**Suggested time:** 6-10 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will study the properties and uses of potash and the formation, location and discovery of potash in Saskatchewan. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Modules 1, 2, 3 and 4 in a pure course.

**Foundational Objectives**
- To demonstrate knowledge of Saskatchewan's landforms and natural environments and their relation to renewable and nonrenewable resources.
- To demonstrate knowledge of the natural processes underlying the formation of mineral, coal and hydrocarbon deposits.
- To understand the geological and geophysical principles underlying the process of resource exploration.
- To become familiar with the history of Saskatchewan's resource industries.

**Common Essential Learnings Foundational Objectives**
- To use correct terminology in discussing potash and potash mining. (COM)
- To use a variety of resources to discover the properties of potash. (COM, IL)

| Learning Objectives | Notes |
|---|---|
| 22.1 To identify the physical and chemical characteristics of potash and examine potash ore. | Students could begin the unit with a class discussion about potash, to assess what students already know about this mineral. Saskatchewan has one of the world's largest deposits of potash. At current levels of consumption, the province could fulfill the world's demand for fertilizer for the next several hundred years.<br><br>Students could study unrefined ore samples and record their observations as to colour, taste (with appropriate precautions), size and shape of crystals, hardness, solubility of lump and crushed forms, etc.<br><br>Students could conduct research to discover the chemical formulae and chemical characteristics of potash and become familiar with the different potash ores.<br><br>Students could begin a glossary of potash-related terms. |
| 22.2 To describe the significance of the Devonian period in the formation of Western Canada's mineral resources and identify commercial minerals, in addition to potash, that formed during the Devonian period. | Students should examine in detail the geological changes that occurred in Saskatchewan during the Devonian period -- including the significance of the Elk Point Sea in the formation of potash. Students should become familiar with terms such as precipitate, halite, carnallite, prairie formation, evaporite and mineral salts.<br><br>Simple evaporation experiments using table salt, potash samples, water and heat illustrate how sedimentation of potash and other minerals could occur. Particularly if normal evaporation processes are used (perhaps assisted by a classroom radiator), students using a hand lens or microscope could examine and draw, photograph, or video the crystal structure of the evaporites.<br><br>Students could research the formation of clays such as bentonite, as well as sodium phosphate. |

| Learning Objectives | Notes |
|---|---|
| 22.3 To explain how potash was used historically. | Students could investigate how the name "potash" originated, where and when potash was first used and the historical uses of potash. |
| 22.4 To describe the location of Saskatchewan potash. | Students could study geological maps to determine the extent of the Prairie Evaporite deposit. The depth and thickness of the deposit are important factors to consider when determining the mining techniques required. Students should compare this deposit to other deposits worldwide. |
| 22.5 To describe how potash was discovered in Saskatchewan. | Rocanville was the site of the first discovery. Students could research methods of exploration for potash and how geologists determine the location of a potential deposit. Potash samples and possibly core samples may be obtained from most potash mines free of charge. |
| 22.6 To explain why mining companies conduct feasibility studies and environmental impact assessments. | Students should understand the meaning of these terms and the significance of the results to the mining companies. They should find out why the studies are done, who does the studies, who pays and what happens to the results. |
| 22.7 To compare the three main potash beds being mined in the province and to map the locations of the operating mines. | Students could explore the differences between the Patience Lake formation, the Belle Plaine formation and the Esterhazy formation. Charts showing the depth, extent and shape of the formations would simplify the explanations and help understand the type of mining used. If they have not already done so in Module 1, students could plot the locations of the present mines on a map that shows the extent of the potash field in Saskatchewan. |

## Module 23:  Potash - Mining and Production (Optional)

**Suggested time:** 7-10 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn about the two different methods of mining potash, will compare the methods as to product, efficiency, cost and location and will describe and explain the difficulties encountered when mining potash. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Module 22 in a pure course.

**Foundational Objectives**
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the technology of the energy and mining industries.
- To understand some of the scientific principles that underlie Saskatchewan's energy resource industries.

**Common Essential Learnings Foundational Objectives**
- To use the Internet and other resources to collect data. (TL)
- To collaborate in planning for a field trip or an interview with a mine representative. (PSVS, CCT)

| Learning Objectives | Notes |
|---|---|
| 23.1 To explain the geological and engineering challenges of establishing a potash mine in Saskatchewan, especially with reference to the characteristics of potash and the location of the potash deposits. | Students should research the Blairmore Formation, the problems associated with the formation, how they were solved and the worldwide significance of this discovery. Diagrams of this problem and its solutions are available on several Internet sites. Terms such as shaft sinking, tunneling, ground freezing, compressive strength, etc. should be included in the explanations. |
| 23.2 To describe conventional underground potash mining as it is done in Saskatchewan. | Students should review and explain conventional mining techniques of "room and pillar" and "stress relief". Students should understand the basic operation of such equipment as the continuous miner, two-rotor borer or road-header machine, conveyor belt, skip, hoist and head frame. They should also be familiar with mining terms like shaft, drift, level, stope. Students could construct a vertical diagram or three-dimensional model showing the locations and terms associated with potash mines. |
| 23.3 To list and explain the facilities housed underground. | Students could research the size and extent of caverns and drifts in an underground potash mine. There are areas for machinery repair, first aid, stockpiling ore, mapping. Students should learn that there are many job specialties in underground potash mines. They should learn about the transportation facilities for workers and equipment, air exchange equipment, electrical services, transportation of the raw ore first to the head frame and then to the mill.<br><br>Students could view the Saskatchewan Resource Series video *Potash* (1989), available from Media Group.<br><br>If at all possible, a field trip to an underground potash mine should be arranged. Alternatively, a representative of one of the potash mines could speak to the students and answer questions. |

| Learning Objectives | Notes |
|---|---|
| 23.4 To become familiar with the process of solution mining in Saskatchewan. | Students should understand the principles of solution mining and be able to explain the steps involved in extracting the ore from the mine. They should investigate the nature and quality of potash that results. Students could assess the reasons for operating a solution mine instead of an underground mine in a particular area.<br><br>Students could map the location of solution mines in Saskatchewan and research the companies that operate these mines. Not all mining companies are based in Canada. Students should be aware of the importance of foreign investment to the industry.<br><br>A representative from a solution mine could be invited to speak to the students, or students could visit the solution mine at Belle Plaine. |
| 23.5 To describe the advantages and disadvantages of each type of potash mine, with respect to cost as well as other factors. | Students could review the two methods and where possible, research the production costs in order to justify their opinions. |

## Module 24: Potash - Refinement, Distribution, Use and Economic Significance (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will learn how potash is refined both from the solid and the liquid (solution) state. As well, students will learn how refined potash is used and its economic effect on agriculture.

**Foundational Objectives**
- To become familiar with the legalities of resource exploration and production.
- To become familiar with the nature and components of Saskatchewan's major underground resources and how they are extracted and purified through refining and processing.
- To become familiar with the nature, location and operation of the distribution systems through which Saskatchewan energy and mineral resources are transported.
- To become familiar with the local and global market for Saskatchewan energy and mineral resources and the immediate and ultimate uses of those resources.

**Common Essential Learnings foundational objectives**
- To use the Internet to investigate potash refining and marketing. (TL)
- To design and carry out experiments on the effect of potash on plant growth. (CCT)
- To prepare graphs and charts illustrating aspects of potash processing and marketing. (COM, NUM)

| Learning Objectives | Notes |
|---|---|
| 24.1 To describe the steps in processing potash ore from the head frame of a conventional mine to the mill. | Students could use Internet resources, charts and information pamphlets to explain the following steps in the refining process:<br>• Flotation<br>• Drying<br>• Screening<br>• Compaction<br>• Recrystallization<br>• Quality analysis.<br><br>Students can refer to prepared flow charts showing the concentration process, or develop their own flow charts in order to understand and explain the process.<br><br>A guided tour of a potash mine and mill would be desirable in connection with this module as well as with Modules 23 and 25. |
| 24.2 To trace the steps in processing potash from a solution mine. | Students should understand that milling potash from a solution mine involves different steps in the flotation, evaporation and crystallization stages of refining the ore, as compared to a conventional mine.<br><br>Students should also be aware of the uses and chemical formulae of the other potash fertilizers. They could explore the significance and benefits of Saskatchewan potash to agriculture locally and internationally. |

| Learning Objectives | Notes |
|---|---|
| 24.4 To investigate how potash (potassium) fertilizers affect plant development. | Students could research the symptoms of potash deficiency in plants, the crops most affected and the value of potassium-rich fertilizers in crop production. The local agronomists might be a good community resource.<br><br>Guided by their teacher through the process of good experimental design, students could set up their own experiments to test hypotheses about the effects of potassium on plant growth. They could use several specimens of the same kind of plant in each of a number of containers with a non-nutrient growth medium such as vermiculite. They could provide distilled water to the control group and an equal volume a basic nutrient mixture containing varying concentrations (including 0%) of potassium, to each of the other specimen groups. By recording data such as colour, robustness, size and number of leaves over several weeks and harvesting the plants and comparing the mean (preferably dry) mass per plant for the various set-ups, students could evaluate their hypotheses and assess the validity and reliability of their findings.<br><br>Students could refer to *Horticulture 10, 20, 30* (2002) for guidance on plant growth experimentation. |
| 24.5 To describe other uses of Saskatchewan potash and its by-products. | Saskatchewan produces potassium chloride. Students could investigate and describe the uses of potash in industry. They could also investigate the uses made of the tailings left after the potash has been extracted. |
| 24.6 To become acquainted with the forms and uses of potash produced outside Saskatchewan. | Students could research potassium nitrate and potassium carbonate. |
| 24.7 To know how and where, potash is transported. | Saskatchewan potash is distributed all over the world. Students could explore the potential and actual markets, how potash is transported, the quantities involved and any safety precautions that are necessary during shipment. As well, they could research the legal requirements involved in exporting to foreign countries.<br><br>Students could explore the impact that the need for rail service to potash mines has had on the continued existence of certain rail lines and the effects on the grain handling industry. |
| 24.8 To be familiar with the economics of potash marketing, including the systems governing price setting, government incentives, taxes and royalties. | Students could review market research data and read newspaper articles, Internet information and company publications, to glean appropriate facts and figures.<br><br>Students could compare the potash markets, both domestic and foreign, with the markets for coal, oil and gas and uranium. A spreadsheet and its graphing function could be used. (TL, NUM) |

## Module 25: Potash - Workplace Safety, Environmental Safety and Careers (Optional)

**Suggested time:** 10-15 hours **Level:** Introductory
**Prerequisite:** None

**Module Overview**
Students will explore occupational and environmental safety standards for the potash industry. As well, students will investigate the social impact of the potash industry, with emphasis on career and employment opportunities. This module is assigned no prerequisites to facilitate its use in survey courses. However, it should be preceded by Module 24 in a pure course.

**Foundational Objectives**
- To assess the environmental impact of resource exploration, production, transport and processing.
- To assess the efforts made by the resource industry to protect the environment.
- To foster an attitude of environmental responsibility.
- To become familiar with the safety standards of Saskatchewan's energy and mining industries and to develop workplace and safety skills appropriate to these industries and related services.
- To become familiar with the nature and requirements of careers and job opportunities in Saskatchewan's energy and mining industries.

**Common Essential Learnings Foundational Objectives**
- To develop a critical appreciation of the standards of occupational health and safety within the industry. (CCT)
- To develop a critical appreciation of the environmental standards and regulations that apply to the industry. (CCT)
- To examine community concerns regarding the impact of potash exploration, mining, processing, transport and use. (PSVS, CCT, COM)
- To use the Internet in exploring career opportunities in the potash industry. (TL, IL)

| Learning Objectives | Notes |
|---|---|
| 25.1 To become familiar with the safety regulations, procedures, equipment and personnel at local or regional mines and processing facilities. | Students could explore safety concerns in regard to operation of heavy equipment, handling of explosives and hazardous chemicals and internal and external exposure to airborne particles.<br><br>Students could interview managers, safety officers, First Responder teams and workers from the potash industry. They could prepare reports on potential hazards, occupational heath and safety laws and regulations, enforced safety procedures and drills, safety and emergency equipment and training, ongoing safety programs and specialist training. Site tours would provide added depth.<br><br>Students should be familiar with Workplace Hazardous Materials Information System (WHMIS). Students could use WHMIS to assess potassium-based chemicals both in the workplace and in the home. |
| 25.2 To investigate the potential environmental effects of potash exploration, mining, milling, transport and use. | Students could do research or conduct interviews to determine the environmental issues that are of local or general concern. They could identify wastes and by-products of mining and milling and investigate the potential effect of these on surface water and the water table. They could examine the dispersal by wind of escaping gases and dust and the potential impact of these on the air, water, soil, plants, animals and people. |

| Learning Objectives | Notes |
| --- | --- |
| | Students could set up an experiment using plants. Using three or four plants in separate containers, water each plant with different concentrations of salt water, representing the contents of a tailings pond after varying amounts of concentration by evaporation and observe the changes. This is a different experiment from the one using fertilizer. |
| 25.3 To become familiar with the legislation in place to protect the environment and how it is applied in practice. | Before a mine can open or shut down, the company must have completed an impact assessment and report, including reclamation procedures and have had it accepted by government regulators. As well as examining samples of these reports, students might explore the financial impact of environmental legislation on the costs of bringing a mine to production.<br><br>Students should also research and report on the nature and frequency of tests done to monitor the environment and the standards of the mine, mill, or other facility. |
| 25.4 To identify and assess the consequences of failure of one or more waste management programs or controls, whether through accident or failure to follow established procedures. | Students could identify emergencies that might arise (e.g., explosion, fire, gas concentration, cave-in, dike or tailings pond failure, leaking storage vessel, transport truck accident) and the solutions in place for these emergencies, as well as the immediate and long-term effects. Students could investigate real emergencies and find out what happened. |
| 25.5 To discuss the economic and social impact, both positive and negative, of the potash industry on the community, families and individuals. | Students could research, conduct interviews or simply brainstorm to assess how local industry affects public services, housing, schools, construction, food services, shopping, recreation, etc. They might also be encouraged to examine the social effects of a fluctuating or transient population and the effects of varying work schedules and seasonal or cyclical employment on the quality of life for individuals and families.<br><br>Students could participate in a "Town Hall Meeting" to discuss the pros and cons of local industry introduction or expansion. A hypothetical situation could be set up with each student or groups of students representing a community organization that either is for or against the proposed development. Students would discuss the benefits or detriments of the project. A student "Mayor" could chair the meeting, or a community leader could be invited to preside. Interest groups might include on-site managers (environmental officer, mine superintendent), federal and provincial authorities, environmental groups, First Nations groups and members of the general public. Areas of local concern could include a possible failure in the waste management system at the mine site, the disposal and storage of waste (tailings), contamination of the air, land, surface water, groundwater or food chain with milling by-products, disruption of the ecosystem in the mine area and decommissioning a mine or mill.<br><br>The teacher could refer to *Saskatchewan Mining: A Resource for Teachers,* "Nesslin Lake Project" for ideas. |

| Learning Objectives | Notes |
|---|---|
| 25.6 To demonstrate familiarity with employment opportunities and careers in the potash industry. | Students could develop a list of careers or jobs, either local or throughout the industry and categorize each as professional/non-professional, technical/non-technical, permanent/seasonal, full time/part time. Gender equity in job opportunities could be explored.<br><br>Students could compare job descriptions and responsibilities with educational levels and training required. General categories might include administration, management, scientific positions, mill workers and blue-collar workers, mine support staff. Students could prepare hypothetical tax returns for selected employees, to get an idea of pay and deductions.<br><br>Students could be introduced to trade unions, bargaining, labour-management relations and issues around non-union contracting.<br><br>Students could prepare a detailed report on one specific career in the industry after research, interviews and, where possible, work study or job shadowing. |

## Module 26A, B, C: Work Study Preparation and Follow-up Activities (Optional)

This module is used to prepare students for work study placement.

**Suggested time:** 5-10 hours **Level:** Introductory, Intermediate and Advanced
**Prerequisite:** None

**Foundational Objectives**

- To be aware of the careers and opportunities in the fields of energy and mines that exist in Saskatchewan and other provinces.
- To integrate classroom learning with work-related learning.
- To increase awareness of employability skills as they relate to the work environment.

**Common Essential Learnings Foundational Objectives**

- To foster an effective use of communication skills in the workplace. (COM)
- To engage in a work study experience and develop entry level workplace skills that may lead to sustainable employment. (PSVS)
- To expand career research beyond the classroom setting. (IL)

| | Learning Objectives | Notes |
|---|---|---|
| 26.1 | To become aware of the expectations of each of the partners in the work study component. (PSVS) | In order to establish a successful working relationship with all of the partners involved in the workplace, it is important to define the expectations of each partner.<br><br>Refer to Guidelines for Work Study, a section of *the Practical and Applied Arts Handbook* for the expectations of business, student, teacher monitor and school. |
| 26.2 | To determine factors that would affect the student contribution in the workplace. (CCT) | The students may formulate a list of what they can bring to the workplace and how each may impact on their jobs.<br>• school subjects<br>• past experiences<br>• self-concept and personality<br>• needs, values and interests<br>• knowledge, skills and attitudes<br>• career goals and plan.<br><br>Ask students to do a self-assessment of skills using the influences in the above list as a guide. Students should identify strengths they can offer community partners. Try to incorporate the value of communication and teamwork in the discussion. |
| 26.3 | To foster an awareness of building good communication in the workplace. (COM) | Discuss verbal and non-verbal communication. List some ways in which negative non-verbal communication may be displayed. Encourage students to role play ways of demonstrating effective techniques of verbal communication on the job when giving or receiving instructions and resolving conflict. With the use of case studies, divide the students into groups and have them role play to show how effective use of communication can resolve conflict on the job. |

| Learning Objectives | | Notes |
|---|---|---|
| 26.4 | To develop a resumé that may be forwarded to a potential employer. | The student will develop a resumé using the correct format.<br><br>The resumé may be used to introduce the student to the employer of a workplace site prior to an interview. Teachers are encouraged to work with other staff members to ensure resumé preparation is taught. Resumé writing is suggested in *English Language Arts 20 and A30, Information Processing 10, 20, 30* and *Career and Work Exploration 20.*<br><br>Students should save the resumé and update it as changes need to be made and references added. |
| 26.5 | To determine student guidelines in preparation for an interview. (COM) | Through class or small group discussions, students may list guidelines for an interview. The instructor should review lists and suggest items that need to be added.<br><br>Outline and describe the three stages of an interview.<br>• The **greeting** involves an introduction between the student and employer. Discuss or demonstrate how this should be done.<br>• The **exchange** is the longest part of the interview where the employer asks a series of questions and engages in a dialogue with the student about information on the resumé and other matters relating to the job.<br>• The **parting** provides closure to the interview and may be just as important as the greeting. Explain how this may be done.<br><br>Provide the students with a list of typical questions that may be asked by employers, or students could make the list. Students may role play an interview. |
| 26.6 | To discuss the post interview. | After the student has completed the interview with the employer, do a follow-up activity. Review the interview with the student using the three stages above as points for discussion. |
| 26.7 | To develop a procedural guide for the work site. | Discuss the following work site items with students.<br>• transportation<br>• hours of work<br>• absence and tardiness<br>• procedures for conflict resolution<br>• role of the student, teacher and work place supervisor<br>• dress code<br>• job description<br>• school and employer expectations. |

| | Learning Objectives | Notes |
|---|---|---|
| 26.8 | To relate feedback from the work placement. | Students provide feedback about work placement including: placement location, type of business, duties, most rewarding experience, most difficult situation and how they handled it.<br><br>It is recommended that each student send a thank you note or card to the employer upon the completion of each work placement. If more than one placement has been made in the course, follow-up activities should be completed after each placement.<br><br>Ensure that students understand these guidelines by asking students to describe each of these items.<br><br>Look for opportunities to introduce and reinforce ideas about Labour Standards, Occupational Health and Safety and WHMIS. Use the *Career and Work Exploration Curriculum Guide*, the *Practical and Applied Arts Handbook,* the Saskatchewan Labour website (http://www.readyforwork.sk.ca) and other recommended resources. |

## Module 27A, B, C: Work Study (Optional)

**Suggested time:** 25-50 hours **Level:** Introductory, Intermediate and Advanced
**Prerequisite:** Module 26A, B, C

**Foundational Objectives**

- To be aware of the careers and opportunities in the fields of energy and mines that exist in Saskatchewan and other provinces.
- To integrate classroom learning with work-related learning.
- To increase awareness of employability skills as they relate to the work environment.

**Common Essential Learnings Foundational Objectives**

- To engage in a work study experience and develop entry level workplace skills that may lead to sustainable employment. (PSVS)
- To expand career research beyond the classroom setting. (IL)

For more information about implementing work study in schools see the Work Study Guidelines for the Practical and Applied Arts included in the *Practical and Applied Arts Handbook*. Teachers need to use or design appropriate learnings objectives for this module; for instance, to demonstrate ability to follow a “Training Plan”.

Consult the *Career and Work Exploration Curriculum Guide* and the Department of Labour for information about Labour Standards, Occupational Health and Safety and WHMIS. If several work study sessions are offered during grade 11 or 12 in a course series, increasing depth should be added to the successive experiences.

Particular care should be taken when investigating sites for students to participate in a work study placement in the energy and mines sector, to insure that the students will be properly trained. Ensure the work site is properly inspected with regard to safety.

## Module 99A, B, C: Extended Study (Optional)

The extended study module may be used once in a 100 hour pure or survey Practical and Applied Arts course. It is important to record the title of the extended study module on the recordkeeping chart. Record 99A for the first extended study module offered in the course series, 99B for the second and 99C for the third.

**Suggested time:** 5-20 hours **Level:** Introductory/Intermediate/Advanced

**Module Overview**
Evolving social and personal needs of society, advances in technology and demands to solve current problems require a flexible curriculum that can accommodate new ways and means to support learning in the future. The extended study module is designed to provide schools with an opportunity to meet current and future demands that are not provided for in current modules in the renewed Practical and Applied Arts curriculum.

The flexibility of this module allows a school/school division to design **one new module per credit to complement or extend the study of pure core and optional modules**, which were configured to meet the specific needs of students or the community. The extended study module is designed to extend the content of the pure courses and to offer survey courses beyond the scope of the available selection of Practical and Applied Arts modules from the pure courses.

The list of possibilities for topics of study or projects for the extended study module approach is as varied as the imagination of those involved in using the module. These optional extended study module guidelines should be used to strengthen the knowledge, skills and processes advocated in the Practical and Applied Arts curriculum.

For more information on the guidelines for the Extended Study module see the *Practical and Applied Arts Handbook* .

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# Appendix A:  Background Information For First-Time Teachers

**Backgrounder #1: Global climatic determiners and Saskatchewan's climate**

Solar radiation reaching the earth may be reflected by clouds, or pass through the atmosphere, either heating the air or reaching the earth's surface.  There, longer wavelengths may be absorbed, warming the land or water surface, or reflected (and possibly being trapped by "greenhouse gases", warming the atmosphere.)  Visible wavelengths may be absorbed by vegetation and some of the energy converted from light to chemical form-- carbohydrates-- in photosynthesis, effectively trapping a portion of the solar energy as producer biomass and forming the foundation of the food chains that sustain biotic communities.

The curvature of the earth's surface affects the intensity of solar radiation per unit of area, with intensity decreasing toward the poles.  As well, the thickness of the atmosphere through which the solar radiation passes is greater as the angle increases, further reducing the amount of energy reaching the surface. Finally, permanent ice caps and seasonal snow cover reflect more energy back into space, further reducing heating.  Result:  the surface receives progressively less heat (and light) energy toward the poles.

The slope of the earth's axis causes significant annual differences, outside tropical regions, in the amount of heat and light reaching the surface as the earth moves around the sun.  Result:  seasons.

The warm regions of the surface heat the air above, reducing its density and causing it to rise and spread poleward in the upper atmosphere.  Air from cooler regions flows in along the surface to replace it, creating cells of atmospheric circulation.  This pattern is further complicated by the earth's rotation.  Result: prevailing winds from certain directions at certain latitudes.

All of this is complicated by the presence of oceans and continents that heat and cool differently.  Land tends to cool at night and get warmer during the day, while ocean temperatures fluctuate little.  Furthermore, outside tropical regions day length varies significantly with the seasons, further complicating annual regional climatic patterns.

Finally, ocean currents and continental topographic features such as mountain ranges, mean elevation and inland water bodies, contribute further variability to climate patterns.

The net effect of all these global factors for Saskatchewan gives most of the province a continental climate, with most weather coming from the northwest or southwest:

- prevailing winds blow from the west and northwest for most of the year (south and east in spring only), with the potential in winter for Arctic air masses over the northern part of the continent to generate cold north winds
- moist air from the North Pacific Ocean flowing over Western Canada in an easterly direction loses much of its water as rain and snow on the Coast Ranges and the Rocky Mountains.  Average annual precipitation in Saskatchewan ranges from 55cm in the northeast to less than 30 cm in the far southwest, of which about 30% falls and remains as snow, making effective precipitation zero for over half the year.  This snow melts in a short time period, creating significant seasonal surface water and runoff during the spring months.  Much of this moisture enters the soil, but a significant amount may be lost due to frozen subsurface soil, rapid run-off and high evaporation as daytime temperatures rise, relative humidity decreases and prevailing winds carry the moist air away
- average annual temperature varies from slightly above freezing to well below freezing, decreasing toward the north.  The period of time when nighttime temperatures do not regularly drop below freezing (frost-free period) lasts from about 70 to 100 days annually, making for a relatively short growing season.  Long cold winters freeze the soil and surface water to depths well below a metre (much deeper in years of sparse snowfall) and trap precipitation as snow, creating conditions of low relative humidity that allows extreme fluctuations between daytime and nighttime temperatures in winter.  Even summertime daily temperature fluctuations are large, due to the low heat-holding capacity of relatively dry air.

Outline of a sample exercise for analyzing a local climate:

Climatic Factors And Their Effects

From information provided by your teacher, construct a standard climograph for (location) and answer the following questions based on it:

- What is the average annual temperature?
- During which months is the average monthly temperature above this annual average?
- How well does this period coincide with the period deciduous trees are in leaf?
- Why are the average monthly temperatures a misleading indicator of plant activity?

The average date for last spring frost in this location is ***; for first fall frost it is ***.

- How many days does this average frost-free period encompass?
- How does this period compare with the leaf season?
- What percentage of the year does the frost-free period represent?
- Is the growing season identical for all wild plants in the environment? Give evidence from your own experience and explain.
- What is the total annual precipitation for this location?
- What is the average monthly precipitation?
- During which months is the precipitation above average?
- What percentage of the annual precipitation falls during this period?
- How well does this period coincide with the leaf season?
- Winter precipitation is effective as moisture only when it melts. During how many months is the effective precipitation therefore zero?
- What is the total precipitation "stored up" during this period?
- What percentage of annual precipitation is this?
- During which month(s) is it released? Using a different colour, sketch this "released moisture" on your climograph.
- When winter precipitation is released by melting, it is not all available to the living community. What happens to the rest of it? Why?
- Which parts of the local environment will be most affected by this relatively rapid release of moisture? In what ways?
- Based on your answers to the previous questions, summarize in a paragraph the ways in which climate influences the nature of the local environment.

**Backgrounder #2: How climatic factors influence global vegetation patterns-- and the Saskatchewan vegetation zones that result**

The dominant vegetation of a region is largely determined by climate. Outside polar and subpolar regions, progressively lower annual precipitation (or longer dry seasons) gives rise to different major plant types:
- high year-round precipitation supports permanently green rainforests
- moderate to high annual precipitation interrupted by an annual dry season supports deciduous forests, which conserve moisture during dry seasons by losing their leaves
- lower annual precipitation (with or without a dry season) favours grasslands (prairie), whose vegetation, dying back to ground level annually, can survive with less moisture or a shorter growing season than can trees
- sparse or infrequent precipitation results in deserts, whose vegetation is adapted to dry air and low soil moisture.

In the circumpolar northern latitudes from around 54 degrees N, precipitation is relatively low (although ranging from desert-like to levels comparable to moist grasslands). Vegetation types in this region are significantly influenced by annual temperature pattern as well as annual precipitation:
- very short summers and soil permanently frozen (permafrost) below a few centimetres favours tundra vegetation consisting of simple plants such as lichens and seed plants that have small waxy evaporation-resistant leaves, minimal annual growth and a short reproduction cycle
- slightly longer summers, in regions without widespread permafrost near the surface, support boreal forests that consist predominantly of slow-growing evergreen trees adapted to low moisture conditions by

having extensive shallow root systems and waxy needle-like leaves that are not shed in the fall and whose active growing season can be thus extended until the soil freezes.

Within Saskatchewan there are two major vegetation regions: boreal forest and grassland. The northern boreal forest, in which evergreen conifers predominate, occupies approximately the northern 40% of the province, while on its southern fringe a broad band of mixed forest (the southern boreal forest), averaging perhaps 150 km wide, extends from northwest to southeast. The boundary between forest and open grassland is quite gradual, with aspen parkland occupying a transition zone averaging perhaps a further 100 km and forested patches appearing well south of that as well. With the parkland included, grassland or prairie occupies approximately the southern third of the province, extending farther north on the west and beginning farther south near the Manitoba border. Within each of these larger regions, differences in soil, residual moisture, elevation and latitude produce local variations in vegetation pattern and associated wildlife.

**Backgrounder #3: Some fundamental concepts in historical geology**

1. Evidence from *absolute dating* (the measurement of time by studying the rate of decay of radioactive elements in rock) indicates that the earth is very old (in the range of 4.6 billion years) and parts of the earth's crust, while perhaps a billion years younger, are very old as well.
2. Changes in the earth's crust and the earth's surface are believed to have occurred gradually, over very long periods of time, by processes we can observe in the present day (*Principle of Uniformitarianism*).
3. The most common of these processes are *weathering* (breaking down of rock through physical and chemical processes such as frost, gravity and the chemical and physical actions of plant roots) and *erosion* (transport of the products of weathering, most commonly through the action of water falling as rain and running from land to sea.)
4. Other major erosional forces include ice, particularly in the form of continental ice sheets and wind.
5. The oldest rocks are a result of molten material that solidified as the earth's crust cooled early in the planet's life; regions of the earth's land surface composed of these rocks are sometimes referred to as *shields*.
6. The layers (*strata*) of rock that make up much of the upper crust of the earth's land masses were formed from sediments deposited in water as a result of weathering of older rocks.
7. In undisturbed strata, any layer (stratum) of rock is older than the stratum on top of it and younger than the stratum beneath it (*Principle of Superposition*).
8. The layers of sediment may contain recognizable remains or other evidence (fossils), or transformed products (e.g., coal, petroleum, natural gas) of plants, animals and microorganisms alive at the time the sediments were deposited.
9. The *relative age* of strata in different locations may be inferred from the kinds of fossil organisms found in them (*index fossils; Principle of Faunal Succession*).
10. Some of these sediments and their fossil content, have been bound by pressure and physical processes into various kinds of rocks classified as *sedimentary*.
11. Other sediments and their fossil content, have been transformed by heat and pressure to form various kinds of rocks classified as *metamorphic*.
12. Any rock that has formed from molten material is classified as *igneous*; shield rock, therefore, is igneous.
13. Not all igneous rock is old: solidified lava, resulting from recent (or ancient) *vulcanism*, is also igneous.
14. Portions of the earth's crust show evidence of having changed position over the course of earth history, both laterally (*plate tectonics* or *'continental drift'*) and vertically (*uplift* or *compression*).
15. In addition to vertical movement of the crust, sea levels have apparently risen and fallen over the course of earth history, sometimes flooding existing land areas for long periods of time and sometimes exposing new land to the forces of weathering and erosion.
16. Portions of the earth's surface beneath the water do not weather appreciably, but may become covered by new strata due to the accumulation of sediments from erosion from the nearby land surfaces; conversely, portions of the earth's surface above sea level do not add new sedimentary strata, but are worn down by weathering and erosion.
17. The boundaries (*unconformities*) between strata are understood to indicate a time period when no sediments were being deposited in a particular location (or perhaps existing deposits were being worn away.)

18. The major strata of the earth's crust have been studied and compared by geologists and placed in a sequence (youngest at the top, oldest at the bottom) called the *Worldwide Geological Column*. No single location on earth, however, has been found to contain all of these strata.
19. Some rocks contain significant amounts of particular *minerals*, which may have formed in igneous rock from molten material from the earth's mantle, or in metamorphic rock by transformation through heat and pressure, or in sedimentary rock by deposition, concentration and transformation through evaporation, compression and chemical activity.
20. Major processes affecting the nature and transformation of the earth's crust tend to be repetitive or cyclic in nature: the *rock cycle,* the *mineral cycle*, the *hydrologic (water) cycle*, the *carbon/carbonate cycle*.

**Backgrounder #4: Some fundamental concepts in physical geography**

1. The earth's present land surface (*topography*) has been shaped over the long term by the movement of crustal plates (*plate tectonics/continental drift*) and *geological uplift* (e.g., mountain building) and in the shorter term by the geological processes of *erosion* and *deposition*, particularly as a result of periods of continental *glaciation*.
2. The land surface is in many places covered with *soil*, a mixture of various-sized mineral particles, living organisms and organic material. Most of the soil mineral residue in temperate regions comprises unconsolidated deposits left behind by the continental glaciations of the past 20 000 years.
3. General global *climatic zones* are determined by a combination of solar energy, the tilt of the earth's axis and the earth's rotation.
4. Each region of the earth's land surface has long-range patterns of temperature, precipitation, solar radiation and air movement-- *climate*. Regional climate is influenced by the patterns of atmospheric circulation and ocean currents and the location of land masses and mountain ranges.
5. The combination of topography, climate and soil determines which kinds of plants and associated animals (*biota*: *flora* and *fauna*) can survive in a particular location.
6. Topographic characteristics such as *elevation* and *slope*, along with the extent of precipitation and evaporation, determine patterns of *surface water* (*ponds, lakes, streams* and *rivers*).

**Backgrounder #5: Some fundamentals of Saskatchewan's geological history**

1. The northern half of Saskatchewan is primarily exposed igneous and metamorphic rock from an ancient shield (the *Precambrian Shield*) that forms much of the northern half of North America. This rock, the oldest of which is estimated at about 3 billion years of age, but interspersed with newer igneous rock due to volcanic activity, has been eroded periodically by water and ice for billions of years. It contains deposits of minerals of kinds and quantities to be economically valuable in the present day, including gold, silver, zinc, copper, iron, uranium and diamond. An ancient (Late Precambrian) plain of exposed sedimentary rock, the Athabasca Formation, lies on top of a portion of the Precambrian Shield in northern Saskatchewan.
2. The Precambrian rock of the southern half of Saskatchewan is overlain by progressively more recent sedimentary strata (less than 500 million years old) in progressively greater depths (up to almost 3000 metres) toward the south, deposited during successive periods of erosion of the northern shield and later, the Rocky Mountains to the west. Within these strata are found economically valuable deposits of petroleum, natural gas, coal, potash, sulfur, sodium chloride and sodium sulfate.
3. The province's topography has been shaped primarily by the most recent of several continental ice sheets (the *Laurentide ice sheet*), which covered virtually the entire province about 18 000 years ago and retreated beyond the northern boundary by about 7 000 years ago, leaving behind hills, plains, lakes, ponds, drainage channels and the unconsolidated sediments, from a few centimetres to several hundred metres in depth, that form the basis of prairie soils.

# Appendix B:  Sample Module Recordkeeping Charts

## Energy and Mines, Petroleum Industry Focus

Student name: ____________________________________________

School name: ________________________________________________________

| Module code | Modules | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI01 | Module 1:  Introduction to Energy and Mines (Core) | | | |
| ENMI02 | Module 2:  Review of Saskatchewan Physical Geography (Core) | | | |
| ENMI03 | Module 3:  Saskatchewan Geology and Geological History (Core) | | | |
| ENMI04 | Module 4:  Sustainability (Core) | | | |
| ENMI05 | Module 5:  Oil and Gas - Formation, Location and Exploration (Optional) | | | |
| ENMI06 | Module 6:  Oil and Gas - Production (Optional) | | | |
| ENMI07 | Module 7:  Cleaning Techniques (Optional) | | | |
| ENMI10 | Module 8:  Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI12 | Module 21:  Alternate Energy Sources - Transportation (Optional) | | | |
| ENMI99 | Module 99A:  Extended Study (Optional) | | | |

## Energy and Mines, Uranium Industry Focus

Student name: ________________________________________

School name: _______________________________________________________

| Module Code | Modules | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI01 | Module 1:  Introduction to Energy and Mines (Core) | | | |
| ENMI02 | Module 2:  Review of Saskatchewan Physical Geography (Core) | | | |
| ENMI03 | Module 3:  Saskatchewan Geology and Geological History (Core) | | | |
| ENMI04 | Module 4:  Sustainability (Core) | | | |
| ENMI12 | Module 12:  Uranium - Formation, Location and Exploration (Optional) | | | |
| ENMI13 | Module 13:  Uranium - Production and Processing (Optional) | | | |
| ENMI14 | Module 14:  Uranium - Refinement, Distribution and Uses (Optional) | | | |
| ENMI15 | Module 15:  Uranium - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI26A | Module 26A:  Work Study Preparation and Follow-up Activities (Optional) | | | |
| ENMI27A | Module 27A:  Work Study (Optional) | | | |

Note:  When the Extended Study, Work Study Preparation and Follow-up Activities and Work Study modules are studied for the first time, record the module number and the letter A (Extended Study Module 99A).  If the module is used at another level, the module is recorded using the letter B (Extended Study Module 99B).

**All recordkeeping charts should be copied to school letterhead.**

## Energy and Mines, Alternate Energy Focus

Student name: ____________________________________________

School name: ____________________________________________________________

| Module code | Modules | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | | | |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | | | |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | | | |
| ENMI04 | Module 4: Sustainability (Core) | | | |
| ENMI19 | Module 19: Alternate Energy Sources - Heat (Optional) | | | |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | | | |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | | | |
| ENMI99C | Module 28C. Extended Study (Optional) | | | |
| ENMI26A | Module 26: Work Study Preparation and Follow-up Activities (Optional) | | | |
| EMNI27A | Module 27: Work Study (Optional) | | | |

Note: When the Extended Study, Work Study Preparation and Follow-up Activities and Work Study modules are studied for the first time, record the module number and the letter A (Extended Study Module 99A). If the module is used at another level, the module is recorded using the letter B (Extended Study Module 99B).

**All recordkeeping charts should be copied to school letterhead.**

## Energy and Mines 10

Student name: ____________________________

School name: ________________________________

| Module code | Modules | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI01 | Module 1: Introduction to Energy and Mines (Core) | | | |
| ENMI02 | Module 2: Review of Saskatchewan Physical Geography (Core) | | | |
| ENMI03 | Module 3: Saskatchewan Geology and Geological History (Core) | | | |
| ENMI04 | Module 4: Sustainability (Core) | | | |
| ENMI05 | Module 5: Oil and Gas - Formation, Location and Exploration (Optional) | O | | |
| ENMI06 | Module 6: Oil and Gas - Production (Optional) | O | | |
| ENMI12 | Module 12: Uranium - Formation, Location and Exploration (Optional) | O | | |
| ENMI16 | Module 16: Coal - Formation, Location and Exploration (Optional) | O | | |
| ENMI19 | Module 19: Alternate Energy Sources - Heat (Optional) | | | |
| ENMI22 | Module 22: Potash - Formation, Location and Exploration (Optional) | | | |

## Energy and Mines 20

Student name: ______________________________________

School name: ____________________________________________

| Module code | Module | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI07 | Module 7: Oil and Gas - Refinement, Use and Economic Effects (Optional) | | | |
| ENMI08 | Module 8: Oil and Gas - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI09 | Module 9: Electricity - Properties and Production (Optional) | | | |
| ENMI10 | Module 10: Electricity - Transmission and Distribution (Optional) | | | |
| ENMI11 | Module 11: Electricity - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI17 | Module 17: Coal - Mining Methods, Production and Uses (Optional) | | | |
| ENMI18 | Module 18: Coal - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI20 | Module 20: Alternate Energy Sources - Electrical Generation (Optional) | | | |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | | | |
| ENMI99B | Module 99B: Extended Study (Optional) | | | |

## Energy and Mines 30

Student name: ____________________________________________

School name: __________________________________________________________

| Module code | Module Title | Hours | Date | Teacher Initial |
|---|---|---|---|---|
| ENMI13 | Module 13: Uranium - Production and Processing (Optional) | | | |
| ENMI14 | Module 14: Uranium - Refinement, Distribution and Uses (Optional) | | | |
| ENMI15 | Module 15: Uranium - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI21 | Module 21: Alternate Energy Sources - Transportation (Optional) | | | |
| ENMI23 | Module 23: Potash - Mining and Production (Optional) | | | |
| ENMI24 | Module 24: Potash - Refinement, Distribution, Use and Economic Significance (Optional) | | | |
| ENMI25 | Module 25: Potash - Workplace Safety, Environmental Safety and Careers (Optional) | | | |
| ENMI26A | Module 26A: Work Study Preparation and Follow-up Activities (Optional) | | | |
| EMNI27A | Module 27A: Work Study (Optional) | | | |

Note: When the Extended Study, Work Study Preparation and Follow-up Activities and Work Study modules are studied for the first time, record the module number and the letter A (Extended Study Module 99A). If the module is used at another level, the module is recorded using the letter B (Extended Study Module 99B).

**All recordkeeping charts should be copied to school letterhead.**

# Appendix D: Career Research Interview Questions

Adapted from *Business Education A Curriculum Guide for the Secondary Level Accounting 10, 20, 30* (Saskatchewan Education 1992).

Interview someone who currently works in this career.

The assignment may be completed independently, in pairs, in small groups, or by whichever method is chosen by the student(s) and teacher. The teacher should encourage students to use a variety of resources to gather information about the career that they are researching. The student may use resources listed in the bibliography, letters, the Internet, phone or a personal interview to gather information.

After the students have discussed different career paths, students may prepare a short journal writing explaining why they are interested in the career area they are about to investigate.

Students may proceed to develop a list of questions to collect the information they require to help them understand more about the career area they have chosen.

The following list of questions may be included in the students' interview project.

1. What is the title of your job?
2. What are your normal duties on the job?
3. What are some of the things that you enjoy about your job?
4. Are there any things about your job that you dislike? What are those things?
5. Does your company have a dress code for employees? What is considered suitable?
6. How often is working overtime required in your job?
7. Do you have to work nights or weekends?
8. What aptitudes and abilities are needed to succeed in your career?
9. What are the post-secondary education and training requirements to enter and advance in your career?
10. Can you give an approximate starting salary for someone just starting out in your occupation? How much does the average person earn after five years? After ten years? What types of employee benefits, such as sick leave or dental plans, do workers in your career usually receive?
11. Do you think the demand for workers in your career will increase or decrease over the next five years? Why?
12. What changes have you seen over the past 5 - 10 years in this career?
13. What are the advantages and disadvantages of entering and being in your career?
14. Is there any advice you would give to a young person just making a career choice?

After the interview session, students may summarize the information they received and draw a conclusion as to whether they would like to learn more about this career. They may also determine whether they would like to join that organization based on their experience.

Students may brainstorm different ways to present their career research to the class. Presentation ideas may include:

- Oral presentation
- Power point presentation
- Written report
- Creating a website with links to career information
- Role playing a student interviewing a career professional
- Role playing a professional promoting his/her career at a career fair.