Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* and in *Physics 3204 Curriculum Guide* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Rationale

The aim of science education in the Atlantic provinces is to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences which provide opportunity to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their futures.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- analysing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment which reflects a constructive, active view of the learning process. Learning occurs not by passive absorption, but rather as students actively construct their own meaning and assimilate new information to develop new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and include opportunities for group and individual work, discussion among students, as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated, provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem-solving involves seeking solutions to human problems. It consists of the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimum solution to a given problem.

Decision Making

The process of decision-making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are not only important in their own right; they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equal opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of and make adaptations to accommodate the diverse range of learners in their classes. In order to adapt to the needs of all learners, teachers must create opportunities that permit students to have their learning styles addressed.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must strive to actively address cultural and gender stereotyping with respect to student interest and success in science and mathematics. Research supports the position that, when science curriculum is made personally meaningful, and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science, and, indeed, for all students.

When making instructional decisions, teachers must consider individual learning needs, preferences, and strengths, and the abilities, experiences, interests, and values that learners bring to the classroom. Ideally, every student should find his/her learning opportunities maximized in the science classroom.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity and validate students when they achieve the outcomes to the maximum of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equal opportunities to experience success as they work toward the achievement of designated outcomes. A teacher should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Writing in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learning. Students, at all grade levels, should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note-making is also an instrinsic part of learning in science that can help students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results help students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in and demonstration of the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

The terms assessment and evaluation are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students, now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible, and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

Regional curriculum in science suggests experiences that support learning within Science-Technology-Society-Environment (STSE), skills, knowledge, and attitudes. It also reflects the three major processes of science learning: inquiry, problem-solving and decision-making. When assessing student progress, it is helpful for teachers to know some activities/skills/actions that are associated with each process of science learning. Examples of these are illustrated in the following lists. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors that focus practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment which tests relationships and variables
- write laboratory reports that meet a variety of needs (limit the production of "formal" reports) and place emphasis on recorded data
- recognize that the quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem; construct a variety of acceptable prototypes; pilot test, evaluate, and refine to meet a need
- present the refined process/product/device and support why it is "preferred"
- recognize that the quality of both the process and the product are important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information in a balanced manner
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a "best" solution

Assessment Techniques

Assessment techniques should match the style of learning and instruction employed. Several options are suggested in this curriculum guide from which teachers may choose depending on the curriculum outcomes, the class and school/district policies. It is important that students know the purpose of an assessment, the method used, and the marking scheme being used. In order that formative assessment support learning, the results, when reported to students, should indicate the improvements expected.

Observation (formal or informal)

This technique provides a way of gathering information fairly quickly while a lesson is in progress. When used formally, the student(s) would be made aware of the observation and the criteria being assessed. Informally, it could be a frequent, but brief, check on a given criterion. Observation may offer information about the participation level of a student for a given task, use of a piece of equipment or application of a given process. The results may be recorded in the form of checklists, rating scales or brief written notes. It is important to plan in order that specific criteria are identified, suitable recording forms are ready, and all students are observed within a reasonable period of time.

Performance

This curriculum encourages learning through active participation. Many of the curriculum outcomes found in the guide promote skills and their application. There is a balance between scientific processes and content. In order that students appreciate the importance of skill development, it is important that assessment provides feedback on the various skills. This may be the correct manner in which to use a piece of equipment, an experimental technique, the ability to interpret and follow instructions, or to research, organize and present information. Assessing performance is most often achieved through observing the process.

Journal

Journals provide an opportunity for students to express thoughts and ideas in a reflective way. By recording feelings, perceptions of success, and responses to new concepts, a student may be helped to identify his or her most effective learning style. Knowing how to learn in an effective way is powerful information. Journal entries also give indicators of developing attitudes to science concepts, processes and skills, and how these may be applied in the context of society. Self-assessment, through a journal, permits a student to consider strengths and weaknesses, attitudes, interests and new ideas. Developing patterns may help in career decisions and choices of further study.

Interview

This curriculum promotes understanding and applying scientific concepts. Interviewing a student allows the teacher to confirm that learning has taken place beyond simple factual recall. Discussion allows a student to display an ability to use information and clarify understanding. Interviews may be a brief discussion between teacher and student or they may be more extensive and include student, parent and teacher. Such conferences allow a student to be proactive in displaying understanding. It is helpful for students to know which criteria will be used to assess formal interviews. This assessment technique provides an opportunity to students whose verbal presentation skills are stronger than their written skills.

Paper and Pencil (assignment or test)

These techniques can be formative or summative. Several curriculum outcomes call for displaying ideas, data, conclusions, and the results of practical or literature research. These can be in written form for display or direct teacher assessment. Whether as part of learning, or a final statement, students should know the expectations for the exercise and the rubric by which it will be assessed. Written assignments and tests can be used to assess knowledge, understanding and application of concepts. They are less successful assessing skills, processes and attitudes. The purpose of the assessment should determine what form of pencil and paper exercise is used.

Presentation

The curriculum includes outcomes that require students to analyze and interpret information, to identify relationships among science, technology, society and environment, to be able to work in teams, and to communicate information. Although it can be time consuming, these activities are best displayed and assessed through presentations. These can be given orally, in written/pictoral form, by project summary (science fair), or by using electronic systems such as video or computer software. Whatever the level of complexity, or format used, it is important to consider the curriculum outcomes as a guide to assessing the presentation. The outcomes indicate the process, concepts, and context for which and about which a presentation is made.

Portfolio

Portfolios offer another option for assessing student progress in meeting curriculum outcomes over a more extended period of time. This form of assessment allows the student to be central to the process. There are decisions about the portfolio, and its contents, which can be made by the student. What is placed in the portfolio, the criteria for selection, how the portfolio is used, how and where it is stored, how it is evaluated, are some of the questions to consider when planning to collect and display student work in this way. The portfolio should provide a long-term record of growth in learning and skills. This record of growth is important for individual reflection and self-assessment, but it is also important to share with others. For all students, it is exciting to review a portfolio and see the record of development over time.

Evaluating Science Communication

Exercising scientific literacy demonstrates an understanding of the nature of science as opposed to just knowing content. The effective use of science communication skills is one component of attaining scientific literacy. These skills include those processes by which information is expressed, using appropriate scientific conventions and conventions of the English language. A successful science student should be able to demonstrate scientific literacy through the proper use of these conventions.

Scientific Conventions

Science students should be able to communicate results according to accepted scientific principles. Students should present scientific information through the proper use of significant figures, formulae, units, and data (graphs, diagrams, or tables). Appendix B outlines the standard scientific conventions used by the Department of Education of Newfoundland and Labrador in provincial examinations for science. These should guide science instruction that scientific conventions are a part of every science students' classroom experiences.

Conventions of the English Language

Science students should be able to demonstrate their understanding of scientific concepts and issues, when explaining a solution to a problem, by using appropriate conventions of English language. These conventions are normally assessed in constructed response questions that require a written solution in essay form. Accepted conventions of English language include such things as correct spelling, proper use of punctuation, and accurate grammar. These conventions ensure that students' responses are clearly presented, well-organized and clearly communicated. Although, in a summative provincial examination, it may be difficult to evaluate these conventions separately, the proper application of these conventions will have a positive affect on student results.

Summative Evaluation

Summative evaluation is directed toward a general assessment of the degree to which outcomes are attained over the reporting period of a course and is used to grade, certify or select students. It is not intended to improve current instruction for the benefit of those being evaluated. It measures what has happened, not what is happening. Results of summative evaluations can serve to indicate areas of strength and needs, and these results can be used to influence later instruction. In that sense, summative evaluation can be used to improve teaching and learning in subsequent reporting periods or years.

Provincial Examination

The Department of Education of Newfoundland and Labrador administers a provincial summative examination for Physics 3204 at the end of each school year. This examination is worth 50% of the student's total mark. It evaluates the cognitive domain of the course by testing the curriculum outcomes at different levels of cognitive learning and at the appropriate depth and breadth required as outlined in the curriculum guide.

Provincial examinations in Newfoundland and Labrador are created by teachers in consultation with Test Development Specialists at the Department of Education. Teachers from across the province are involved in all levels of the exam development process. These include item writing, exam creation, field testing, validation of items, and marking.

Evaluating Higher Order

By its very nature, physics is based on a problem solving philosophy and students tend to spend more time applying theories and concepts than in other sciences. It lends itself, therefore, to assessing at higher levels of Bloom's taxonomy. Teachers should be diligent in ensuring that assessment items requiring higher order levels are included in school-based evaluation instruments throughout the course.

Most outcomes can be evaluated at all cognitive levels. The cognitive level of examination items will not require students to have a greater knowledge than indicated by the outcomes. For the purpose of constructing provincial examinations, the Department of Education of Newfoundland and Labrador has summarized Bloom's categories of competence into three levels of cognitive learning. These levels are outlined below.

Sample Levels

Level 1

The student demonstrates attainment of outcomes through the ability to recall learned materials and to grasp the meaning of material. It can range from the recall of simple facts to translating material from one form to another. It represents the lowest level of learning and understanding of outcomes.

For example,

A rock is thrown horizontally off the roof of a building at 18 m/s. What is the horizontal component of the velocity just before the rock hits the ground?

(A) -18 m/s

(B) -9.8 m/s

(C) 9.8 m/s

(D) 18 m/s

Level 2

The student demonstrates attainment of outcomes through the ability to apply rules, concepts, principles, laws, or theories.

For example,

(i) An 1.0×10^{3} W bulb burns for 2.0 h. What is the total cost of the electricity used if the rate is eight cents per kilowatt hour?

(A) $0.04

(B) $0.16

(C) $0.25

(D) $1.60

(ii) What is the frequency of photons that have a momentum of 2.80×10^{-27} kg m/sS

Level 3

The student demonstrates attainment of outcomes through the ability to use learned materials in new situations, the ability to break material down into its component parts so that its organizational structure may be understood, the ability of putting parts together to form a new whole, or the ability to judge the value of a piece of information.

For example,

(i) Light of a particular wavelength is incident on a metal surface. If electrons are emitted from this surface, what situation would result in more electrons per unit time with less kinetic energy per electron?

	Intensity	Wavelength
(A)	decrease	decrease
(B)	decrease	increase
(C)	increase	decrease
(D)	increase	increase

(ii) A car is moving around a horizontal curve with a radius of 50.0 m. If the coefficient of static friction is 0.75, what is the maximum speed for the car to travel safely around the curve without skidding?

Physics 3204 Provincial Examination

Format

The provincial examination in Physics 3204 is composed of two parts. Part I contains 50 multiple choice questions that measure students' achievement at all levels of cognitive learning. Part II contains constructed response questions that measure students' achievement only at the higher levels of cognitive learning (level 2 and 3). Part 1 has a value of 50% and part II has a value of 50%. Students are required to answer all questions on the examination. To ensure highest marks possible, their responses to part II questions must be clearly presented in a well-organized manner with proper use of units, formulae and signigicant figures where appropriate.

Table of Specifications

A table of specifications is created by teachers and is reviewed annually during provincial examination development. It guides the construction of each provincial examination and covers all parts of the examination. It assigns the mark value to each unit and each cognitive level. The total percentage for each unit directly corresponds to the suggested time lines for teaching each unit.

Physics 3204 Table of Specifications

Unit	Cognitive Level %			
	1	2	3	Total %
Force, Motion, and Energy	8	24	8	40
Fields	8	24	8	40
Matter-Energy Interface	4	12	4	20
Total %	20	60	20	100%

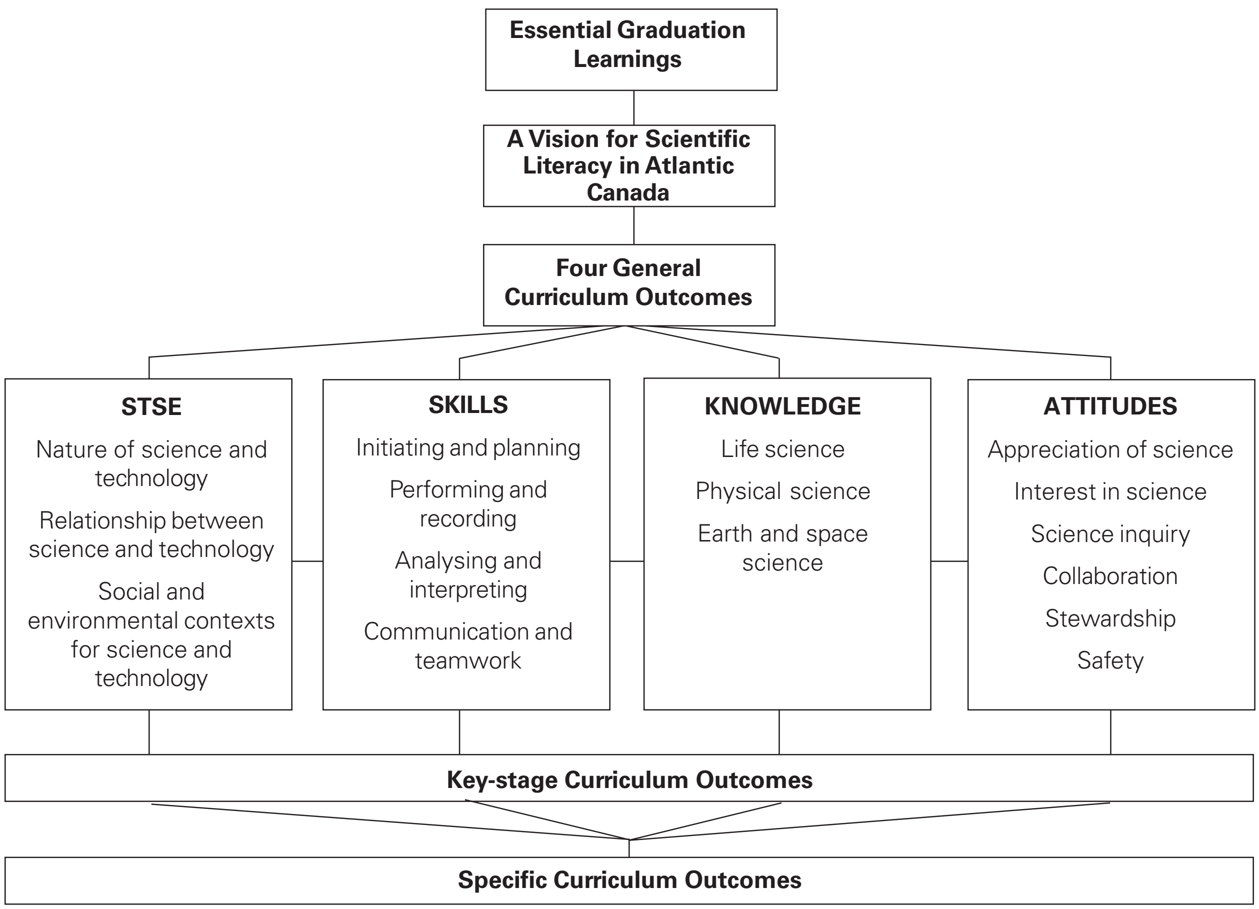
The evaluation instrument will contain 15-20% of core lab and STSE (Science, Technology, Society, and the Environment) content.

Outcomes

Outcomes Framework

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The conceptual map shown in Figure 1 provides the blueprint of the outcomes framework.

FIGURE 1



This curriculum guide outlines course-specific curriculum outcomes, and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult the *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations, not in terms of individual school subjects, but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are:

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Spiritual and Moral Development

Graduates will demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical conduct.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K to 12*.

Specific Curriculum Outcomes

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each grade level.

Curriculum Guide Organization

Specific curriculum outcome statements describe what students should know and be able to do at the end of each course. They are intended to serve as the focus for the design of learning experiences and assessment tasks. Specific curriculum outcomes represent a reasonable framework for assisting students to achieve the key-stage and the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each course. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a course appear in the guide is meant to suggest a sequence. In some cases the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept which is then extended in a subsequent unit. Likewise, it is possible that one unit focusses on a skill or context which will then be built upon later in the year.

It is also possible that units or certain aspects of units can be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful, and socially and culturally relevant, contexts.

Unit Organization

All units comprise a two-page layout of four columns as illustrated in Figure 2. In some cases the four-column spread continues to the next two-page layout. Each unit comprises outcomes grouped by a topic which is indicated at the top of the left hand page.

Column One: Specific Curriculum Outcomes

The first column lists a group of related specific curriculum outcome statements. These are written in the context of Newfoundland and Labrador Physics 3204 and are based on the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in brackets after the outcome statement. Some STSE and skills outcomes have been written in an age-appropriate context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary in order to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column Two: Suggestions for Learning and Teaching

The second column provides suggestions for the learning environment and experiences that will support students' achievement of the outcomes listed in the first column. Elaborations of the outcomes may also be included in this column, as well as background information.
The suggestions in this column are intended to provide a holistic approach to instruction. In some cases, the suggestions in this column address a single outcome; in other cases, they address a group of outcomes.

Column Three: Suggestions for Assessment

The third column provides suggestions for ways that students' achievement of the outcomes may be assessed. These suggestions reflect a variety of assessment techniques which include, but are not limited to, informal/formal observation, performance, journal, paper and pencil, interview, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources

The fourth column identifies sources of materials and ideas, which may assist in the learning and teaching of the outcomes. These resources do not address the entire scope of the science curriculum. Since a resource-based learning philosophy is espoused, teachers are encouraged to use other appropriate resources, which will contribute to the achievement of the outcomes.

FIGURE 2
Curriculum Outcomes Organization:
The Four-Column, Two-Page Spread

Topic			
Outcomes • Outcome based on pan-Canadian outcomes (###,###) — clarification outcomes • Outcome based on pan-Canadian outcomes (###) — clarification outcomes — clarification outcomes	**Suggestions for Learning and Teaching** Suggested activities and elaborations of outcome Suggested activities and elaborations of outcome	**Suggestions for Assessment** **Informal/Formal Observation** **Performance** • sample assessment item (###) **Journal** **Paper and Pencil** **Interview** • sample assessment item (###) **Presentation** **Portfolio**	**Resources** Authorized and recommended resources that address outcomes

Unit Overview

At the beginning of each unit, there is a two-page synopsis. On the first page, introductory paragraphs give a unit overview. These are followed by a section that specifies the focus (inquiry, problem-solving, and/or decision-making) and possible contexts for the unit. Finally, a curriculum-links paragraph specifies how this unit relates to science concepts and skills that will be addressed at later grades so that teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that will be addressed in the unit. The numbering system used is the one followed in the pan-Canadian Science document:

100s - Science-Technology-Society-Environment (STSE) outcomes

200s - Skills outcomes

300s - Knowledge outcomes

400s- Attitude outcomes (see pages 22-23)

These code numbers appear in brackets after each specific curriculum outcome (SCO).

Within each unit, pan-Canadian outcomes are written in the context of Newfoundland and Labrador's Physics 3204 curriculum.

FIGURE 3
Unit Overview

Unit Title: Unit Overview		**Unit Title: Curriculum Outcomes**		
Introduction	Synopsis of the unit	**STSE**	**Skills**	**Knowledge**
Focus and Contexts	Focus: inquiry, decision-making, or problem-solving. Possible contexts suggested	###Science-Technology-Society-Environment outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Knowledge outcomes from *Common Framework of Science Learning Outcomes K to 12*
Curriculum Links	Links to concepts studied within the K to 12 science curriculum			

Attitude Outcomes

It is expected that certain attitudes will be fostered and developed throughout the entire science program, entry to grade 12. The STSE, skills, and knowledge outcomes contribute to the development of attitudes and opportunities for fostering these attitudes are highlighted in the *Suggestions for Learning and Teaching* section of each unit.

Attitudes refer to generalized aspects of behaviour that are modelled for students by example and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by allowing for interaction with their intellectual development and creation of a readiness for responsible application of what they learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcomes statements for attitudes are written for the end of grades 3, 6, 9, and 12. These outcomes statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

From grades 10 to 12 it is expected that students will be encouraged to . . .

Appreciation of science

436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not

437 appreciate that the applications of science and technology can raise ethical dilemmas

438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds

Evident when students, for example,

- consider the social and cultural contexts in which a theory developed
- use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on an STSE issue
- recognize the usefulness of being skilled in mathematics and problem solving
- recognize how scientific problem solving and the development of new technologies are related
- recognize the contribution of science and technology to the progress of civilizations
- carefully research and openly discuss ethical dilemmas associated with the applications of science and technology
- show support for the development of information technologies and science as they relate to human needs
- recognize that western approaches to science are not the only ways of viewing the universe
- consider the research of both men and women

Interest in science

439 show a continuing and more informed curiosity and interest in science and science-related issues

440 acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research

441 consider further studies and careers in science- and technology-related fields

Evident when students, for example,

- conduct research to answer their own questions
- recognize that part-time jobs require science- and technology-related knowledge and skills
- maintain interest in or pursue further studies in science
- recognize the importance of making connections between various science disciplines
- explore and use a variety of methods and resources to increase their own knowledge and skills
- are interested in science and technology topics not directly related to their formal studies
- explore where further science- and technology-related studies can be pursued
- are critical and constructive when considering new theories and techniques
- use scientific vocabulary and principles in everyday discussions
- readily investigate STSE issues

Scientific inquiry

442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations

443 use factual information and rational explanations when analysing and evaluating

444 value the processes for drawing conclusions

Evident when students, for example,

- insist on evidence before accepting a new idea or explanation
- ask questions and conduct research to confirm and extend their understanding
- criticize arguments based on the faulty, incomplete, or misleading use of numbers
- recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen
- expend the effort and time needed to make valid inferences
- critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation
- critically assess their opinion of the value of science and its applications
- criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist
- insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged
- seek new models, explanations, and theories when confronted with discrepant events or evidence

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

For grades 10 to 12 it is expected that students will be encouraged to . . .

Collaboration

445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas

Evident when students, for example,

- willingly work with any classmate or group of individuals, regardless of their age, gender, or physical and cultural characteristics
- assume a variety of roles within a group, as required
- accept responsibility for any task that helps the group complete an activity
- give the same attention and energy to the group's product as they would to a personal assignment
- are attentive when others speak
- are capable of suspending personal views when evaluating suggestions made by a group
- seek the points of view of others and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the persons
- evaluate the ideas of others objectively
- encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making
- contribute to peaceful conflict resolution
- encourage the use of a variety of communication strategies during group work
- share the responsibility for errors made or difficulties encountered by the group

Stewardship

446 have a sense of personal and shared responsibility for maintaining a sustainable environment

447 project the personal, social, and environmental consequences of proposed action

448 want to take action for maintaining a sustainable environment

Evident when students, for example,

- willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation
- assume part of the collective responsibility for the impact of humans on the environment
- participate in civic activities related to the preservation and judicious use of the environment and its resources
- encourage their peers or members of their community to participate in a project related to sustainability
- consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors
- participate in social and political systems that influence environmental policy in their community
- examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- willingly promote actions that are not injurious to the environment
- make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations
- are critical-minded regarding the short- and long-term consequences of sustainability

Safety

449 show concern for safety and accept the need for rules and regulations

450 be aware of the direct and indirect consequences of their actions

Evident when students, for example,

- read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood
- criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment
- consider safety a positive limiting factor in scientific and technological endeavours
- carefully manipulate materials, cognizant of the risks and potential consequences of their actions
- write into a laboratory procedure safety and waste-disposal concerns
- evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms
- use safety and waste disposal as criteria for evaluating an experiment
- assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place
- seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present