Public and Catholic District School Board Writing Partnership

Course Profile

(for a Locally Developed Course)

Essential Science

Grade 9

· *for teachers by teachers*

Course Profiles are professional development materials designed to help teachers implement the new Grade 9 secondary school curriculum. These materials were created by writing partnerships of school boards and subject associations. The development of these resources was funded by the Ontario Ministry of Education. This document reflects the views of the developers and not necessarily those of the Ministry. Permission is given to reproduce these materials for any purpose except profit. Teachers are also encouraged to amend, revise, edit, cut, paste, and otherwise adapt this material for education purposes.

Any references in this document to particular commercial resources, learning materials, equipment, or technology reflect only the opinions of the writers of this sample Course Profile, and do not reflect any official endorsement by the Ministry of Education or by the Partnership of School Boards that supported the Production of the document.

Acknowledgements

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The new *Ontario Secondary Schools, Grades 9 to 12: Program and Diploma Requirements (OSS)*, 1999 enables school boards to develop three local compulsory-credit courses, one in each of the following subjects: English, Mathematics, and Science. To provide a model of how these courses could be developed, the Ministry of Education has funded the following sample Course Profiles: "Essential English," "Essential Mathematics," and "Essential Science."

The *Guide to Locally Developed Courses, Grades 9 and 10: Approval Requirements and Procedures* provides information to assist school boards in preparing their requests to the Ministry of Education for approval of their own Grade 9 locally developed courses, to be offered in the 1999-2000 school year, under OSS. The document is available on the ministry's web site at http://www.edu.gov.on.ca.

Course Overview (for a locally developed course)
Essential Science, Grade 9

School:
Department: Science
District:
Course Title: Essential Science (for a locally developed course)
Grade: Nine
Course Type:
Development Date: April - July 1999
Ministry Course Code:
Credit Value: 1.0
Secondary Policy Document: Science

Description/Rationale

This course enables students to deepen their knowledge and understanding of the basic concepts in biology, chemistry, earth and space science, and physics; to develop practical skills in science investigation; and to apply their knowledge and skills to everyday situations. Students conduct investigations into practical problems and issues related to cells and reproduction, the structure and properties of elements and compounds, static and current electricity, and astronomy and space exploration. A variety of hands-on activities assist students to acquire concepts. Students will use different reporting strategies to facilitate the development of communications skills.

The overall aim is to ensure the scientific literacy of the students. This is accomplished through the promotion of the three goals of science education:

- to understand the basic concepts of science;
- to develop the skills, strategies, and habits of mind required in scientific inquiry;
- to relate science to technology, society and the environment.

This sample profile for Grade 9 Essential Science is to provide a model for school boards who are preparing a locally-developed course as described in *Ontario Secondary Schools, Grade 9 to 12, Program and Diploma Requirements* (1999), section 7.1.2 (page 42). *Success in science is for all students*. In developing this profile the writers looked first at the image of the learner who would be recommended for or choose this course. The activities and resources have been chosen so that these students experience success in meeting the science expectations. The profile provides a basis from which teachers can develop a Grade 9 science course to meet the needs of their students.

Teacher and student resources are listed in this profile. Additional resources are included in the appendices to each unit. Other Teacher Support Materials (TSM) that have not been included in this profile may be found on the provincial web site of the Science Teachers' Association of Ontario (STAO) at www.stao.org.

Although there may be a tendency to shortchange one of the units, the requirements are that you give equal weighting to each of the science strands.

This course could be enriched and specialized by combining it with the Learning Strategies course (*Choices Into Action: Guidance and Career Education Program Policy for Ontario Elementary and Secondary Schools, 1999*) for 2 credits offered over 2 years. The course objectives, the expectations, and the evaluation procedures for each course must be addressed.

Unit Titles with Sequence and Timing

This profile outlines a progression of science and communications skills through which the student will move. Local circumstances may dictate some variation in the sequence suggested in the chart below, but it is essential to begin with Unit 1 which introduces necessary laboratory skills, communications strategies, and safety and laboratory routines which are used in subsequent units. Unit 6, the culminating task, must be the last unit in the course.

Unit 2, Biology, has been assigned slightly more time than the other units because entry skills and the use of the Science Learning Log are still being learned.

Observation of night skies in the Astronomy unit is best done sometime between late November and early February, when the nights are long and there is the option for direct observation in the early evening or morning. It may be necessary in semestered schools to deliver part of the astronomy unit near the beginning of semester 2 to do this.

The teacher is responsible for creating a year-long plan, detailed timing for the course so that all units are adequately addressed, and for deciding the best order of activities for a given unit. It is important to read through the entire unit prior to making specific plans, since later activities may have prerequisite learnings from within the unit.

Timing	Title	Skill Development
1 (10 h)	Introduction: Setting the Stage	• Selection of cognitive and manipulative skills for science inquiry, establishing routines, communication skills, and laboratory skills.
2 (24 h)	Biology: Cells and Reproduction	• Inquiry and laboratory skills development • Communication skills
3 (21 h)	Chemistry: Exploring Matter	• Inquiry with experimental focus
4 (21 h)	Physics: Electricity	• Inquiry with a design focus
5 (21 h)	Earth & Space Science: Space Exploration	• Developing investigative skills beyond classroom
6 (13 h)	Culminating Task: Making Connections	• Final assessment task

Unit Descriptions

Unit 1: Introduction: Setting the Stage

Time: 10 hours

Unit Description: Setting the Stage touches on each of the four science strands. Students are introduced to different types of lab investigations that are related to commercial laboratories. Opportunities are provided for the review of some of the skills and strategies of scientific inquiry (e.g., lab procedures, proper use of lab tools and safety equipment, graphing). Opportunities are built into the unit for diagnosing the students' achievement level in communication. Students will learn how to complete the Science Learning Log (SLL) which is an organizing template used throughout this course to develop and extend literacy skills, and to make connections to the world outside and other parts of their learning. Assessment is an integral part of learning and students are introduced to a variety of assessment tools used throughout the entire course. These tools can be used for diagnostic, formative, and summative assessment.

Strand(s) and Expectations

Strand(s): Biology, Chemistry, Earth and Space Science, Physics
Specific Expectations: BY1.01, BY2.01B/C/E, BY2.02, CH1.01, CH2.01A/B/C, CH3.04, PH2.01C/E, ES3.01

Unit 2: Biology: Cells and Reproduction

Time: 24 hours

Unit Description: Students review the cell model and the difference between plant and animal cells. The unit establishes the necessity of cell division for the reproduction of an organism. Some microscope work is used for investigations. Students explore the characteristics of sexual and asexual reproduction with a focus on the commercial use and applications of asexual reproduction. The characteristics of human reproduction are examined in detail with exploration into environmental factors and lifestyle choices that affect fetal development.

Strand(s) and Expectations

Strand(s): Biology
Overall Expectations: BYV.01, BYV.02, BYV.03
Specific Expectations: BY1.02 to .07, BY2.01A/B/C/D/E, BY2.02, BY3.01, BY3.02

Unit 3: Chemistry: Exploring Matter

Time: 21 hours

Unit Description: Students develop a concept of matter on the atomic and macroscopic level. Laboratory investigations assist students in understanding that the identity, reactions, and uses of substances are based on their individual properties. Reporting in a variety of formats increases literacy skills. Students gain a renewed respect for safety in and outside the laboratory setting.

Strand(s) and Expectations

Strand(s): Chemistry
Overall Expectations: CHV.01, CHV.02, CHV.03
Specific Expectations: CH1.01-.04, CH2.01A/B/C/D/E/F, CH2.02-05, CH3.01-.04

Unit 4: Physics: Electricity

Time: 21 hours

Unit Description: Students gain an understanding of static and current electricity. Students build simple circuits that model circuits used in everyday life. They analyze this form of energy, energy transformations, conservation of energy, and the impact of each. Safety, experimentation, collaboration and literacy are part of the focus of this unit.

Overall Expectations: PHV.01, PHV.02, PHV.03
Specific Expectations: PH1.01-.04, PH2.01A/B/C/D/E/F, PH2.02, PH3.01-.03

Unit 5: Earth and Space Science: Exploring the Universe

Time: 22 hours

Unit Description: Students explore the solar system and the universe and study applications of space science to better understand how scientists investigate the universe, how the technologies resulting from space exploration affect their lives; and where humans fit into the universe. Skills of inquiry, problem solving, collaboration, and communication are developed.

Strand(s) and Expectations

Strand: Earth and Space Science
Overall Expectations: ESV.01, ESV.02, ESV.03
Specific Expectations: ES1.01-.04, ES2.01A/B/C/D/E, ES2.02, ES3.01-.03

Unit 6: Culminating Activity: Building A Space Station

Time: 13 hours

Unit Description: This unit acts as the summative assessment for the course and counts for 30% of the students' final evaluation. The format allows students to demonstrate their level of achievement in an alternative manner that does not depend on a single final written examination. The unit assesses the vocabulary, concepts, scientific processes, communication skills and connections developed throughout the four strands of the course. Assessment addresses each of the four categories in the Achievement Chart for Science and each of the goals of education. Students use video-clips, laboratory investigations, small group discussion and a variety of appropriate reading materials to build a model space station.

Expectations from each of the four strands are integrated into the unit. Teachers may choose alternative products for students to demonstrate their creativity and understanding. Alternatives may include videotape, audiotape, cartoon, song, poster, dramatic skit, drawings, and computer-generated product. Unit tasks and assessment may need to be adjusted accordingly.

Course Notes

The students who are taking this course experience success when:

- resources are geared to an appropriate reading level;
- connections to their lives are apparent;
- instructions are clear and specific;
- laboratory activities are broken into a number of small steps;
- several different activities are used to develop and reinforce a concept;
- participation is low risk;
- routines are structured to assist organization;
- considerable practice is included.

It is important that students develop science *literacy* appropriate to their abilities, a questioning attitude, and a knowledge and skills base sufficient to enter a Grade 11 Workplace Science course.

Students should be taught ways of improving their literacy skills (i.e. use of vocabulary sheets, dictionaries, and spell-check programs on the computer, reporting to different audiences, using a variety of reporting formats, oral explanations). The Science Learning Log (SLL), described later in this section, is a structured vehicle to improve student vocabulary, reflection on, application of the new knowledge, and making connections.

Communications and applications are emphasized throughout this course. Teachers should collect a variety of appropriate, science-related newspaper and magazine articles, which can be adapted to use for reading and research assignments (see Appendices 1.11 and 1.12 as examples). The teacher/librarian can also assist in collecting relevant materials.

This profile is planned so that the knowledge, skills, and concepts necessary for entry to Grade 11 Workplace Science have been addressed.

Prior Learning Required

It is expected that students taking this course will have achieved some of the Grades 1-8 skills and strategies or science inquiry expectations. As such, Unit 1 should take on a diagnostic role. Then remediation needs to be provided so that students will have the entry skills and knowledge for success in this course.

Appendix OV-6: Summary of *The Ontario Curriculum, Grades 1-8: Science and Technology, 1999* shows the items (i.e., topics, vocabulary, equipment, design and construct activities) addressed in each grade and strand. Teachers should make every effort to review/reteach the concepts and skills necessary for this unit in a new context.

Throughout the course, opportunities should be made to identify misconceptions and correct them (i.e. There is no gravity in space; Plants, as living things, breathe in oxygen. A cloned plant or animal only requires the division of a single parent cell). These can be identified by listening to class discussions, looking at brainstorming charts, and reading Science Learning Log entries.

Teaching/Learning Strategies

The goal of this course is to enhance student learning by building confidence through engaging curriculum. The following teaching/learning strategies have been infused into the curriculum in order to provide students with the opportunity to experience success.

Instructional strategies for Grade 9 Science:

- provide an opportunity for success because success motivates students. Anything that increases motivation increases achievement.
- include whole class and small group instruction;
- address a variety of learning styles in each unit;
- can be modified for special needs students;
- ensure maximum student engagement in the learning;
- build in opportunities for practice and provide frequent feedback;
- include clear goals and expectations;
- include individual and directed learning;
- use graphic organizers (e.g., Science Learning Log, Venn Diagrams, mind maps, tables);
- provide interesting and relevant curriculum;
- move from concrete (simple) to abstract (complex);
- provide challenging experiences;
- provide opportunities for genuine inquiry (e.g., generate questions and communicate findings in a variety of ways);
- use short tasks with built in success (e.g., Science Learning Log);
- deliver concepts in small sequential steps;
- link assessment tools to the expectations addressed. Have the assessment tools written in language students understand?
- encourage creativity and choice in the development of student products (e.g., projects);
- provide a structured environment with built in routines;
- provide opportunities for the use of information technologies (e.g., computers, video and digital cameras, scanners, Internet);
- support opportunities for making connections between the classroom curriculum and technology, society and the environment;
- allow for the development of literacy skills.

Science Learning Log Expectations

The Science Learning Log (SLL) is used to develop literacy, creativity, and promote reflective thinking and to make connections beyond the classroom (see Unit 1: Task 2.2 and 3.3 as samples). The SLL is a strong graphic organizer or template to assist students in their learning. Students should become familiar with the structure (Appendix OV-1) and assessment criteria for completed SLL worksheets (SLL Rubric, Appendix OV-2) early in the course, as it is an integral part of the Essential Science program.

The Science Learning Log worksheets are meant to remain as a predictable, structured one-page activity, which invites the student to be successful at communicating knowledge about a topic in written form. Some students may find writing challenging and it may be necessary to provide appropriate support where required (see Accommodations section for alternative response format).

The SLL entry worksheets should be integrated into the student's notebook. Both the notebook and the learning log should be assessed early and often to assist the student in keeping a good record of the classroom activities and in improving their literacy. The Notebooks Are Important! (Appendix OV-5) can be used as both a formative and summative checklist for assessing notebooks.

The format of the SLL includes the following:

- Four or five key *vocabulary* words derived from individual unit activities are selected for each SLL entry.
- Each vocabulary word is to be defined based on information from class notes or laboratory activities.
- Vocabulary words are used in sentences to answer *focus questions or tasks* on an activity topic. (Refer to SLL Rubric, Appendix OV-2).
- *Connection questions* that guide the student to reflect on work to make connections to the community, to set goals for learning, to ask more questions, or to prepare for the culminating activity.

The Science Learning Log Rubric (Appendix OV-2) used as both a formative and summative assessment tool. Note: Emphasis of the SLL is not to evaluate spelling, rather it is to allow the student to take newly learned vocabulary and correctly apply it. Students should be encouraged to use other strategies such as computer spell-check and peer/teacher editing to revise written work before submitting it for summative assessment.

Reading For Understanding

Improving both literacy and science literacy are goals of this course. Improvement in reading and comprehension are fostered by practice. A variety of Reading for Understanding worksheets are suggested throughout the course. Two examples are given in Appendix 1.11 "What Are Solar Cells Good For?" and Appendix 1.12 "Space Travel Gives Us the Technology for Heart Pacemakers". In each case the article is short and the vocabulary should be appropriate for the student reading it. The two examples have been developed from articles in magazines and journals.

The reading passage should be followed by focus questions, where possible. These questions should focus on knowledge, inquiry/application and making connections. This type of structured sheet helps students organize their thinking and responses. Organization helps achievement.

Creating these Reading for Understanding worksheets requires teachers to collect articles from newspapers, magazines, and books that relate to the expectations of this course, and develop one or two articles per year for your students. These could be shared through the STAO Teacher Support Materials.

Tasks Identified by Type

Within each unit, the expectations have been grouped and activities developed in which the students can practise, demonstrate, communicate, or apply the knowledge or skill.
Each of these activities has been subdivided into tasks.
Diagnosis, learning, and assessment are all integral parts of this course. Each of the tasks has been identified as a diagnostic task, a learning task, or an assessment task.

Science Fairs and Science Olympics

Science Fair projects or participation in Science Olympics address a number of expectations in this course, including improving inquiry skills, communicating, deepening knowledge and understanding and making connections. See comments in each unit of the Public District School Board *Grade 9 Science Profiles* for both Academic and Applied courses on Science Fairs for additional reasons for including this teaching/learning strategy.

Accommodations

The following considerations apply to each of the units in this course:

1. Any student or group of students may require accommodations in response to specific needs at different times and in varied circumstances.
2. Appropriate accommodations should be part of the planning for each unit activity in terms of the particular students in the class and their specific needs.
3. Instructional and assessment activities must take into account the strengths, needs, learning expectations and accommodations as identified in the Individual Education Plan, whether students are formally identified or not. (Regulation 181/98)
4. Accommodations to curriculum, instruction, assessment and evaluation may include but are not limited to:
    - simplified tasks and activities;
    - use of specialized equipment and assistance;
    - ensure that peer helpers are available when students are working in small groups;
    - provide handout sheets with sample calculations and specific skill instructions as required;
    - help students create data charts into which they will be recording information;
    - advise Special Education staff in advance when students will be working on major assignments;
    - record key words on the board when students are expected to make their own notes;
    - allow students to report verbally to a scribe (teacher or student) who can help in note making;
    - use a tape recorder or computer as an alternative to written responses;
    - permit students a wide range of options for recording and reporting their work to accommodate students with weak writing skills (e.g., drawings, diagrams, flow charts, concept maps);
    - extend timelines to give students more time to process language and put their thoughts into words.

English as a Second Language/English Literacy Development

- Have students keep a science dictionary of terms using pictures and first language words.
- Give an activity that requires reading to these students in advance.
- Permit the use of a translation dictionary on assessments.
- Provide additional time on assessments for dictionary use and language processing.
- Have the teacher/librarian identify resources at an appropriate reading level when research is required.
- Advise ESL/ESD staff in advance when significant written work will be required.

(Adapted from Learning Strategies, *Public District School Board Writing Partnership, Course Profile, Science, Grade 9, Applied, 1999)*

Co-operative Small Group Learning

Students taking this course need support from one another as well as from their teachers. They also require additional work on co-operative and social skills. As such, opportunities should be taken to include Co-operative Small Group Learning (CSGL) structures, appropriate to their level of sophistication, as a learning/teaching strategy. Appendix OV-3 outlines a variety of structures that can be used in the classroom. Structures such as "Graffiti" are interesting brainstorming techniques that are highly effective in learning.

Assessment/Evaluation

The primary purpose of assessment and evaluation is to improve student learning. Information gathered through assessment helps teachers to determine students' strengths and weaknesses in their achievement of the curriculum expectations in this course. This information also serves to guide teachers in adapting the science curriculum and instructional approaches to students' needs and in assessing the overall effectiveness of programs and classroom practices.

Students must be trained on how to use the various assessment tools (e.g., rubrics, scoring scales) in a process of self-reflection, so they can see how to improve their work.

An *expectation* is a statement of what the students are expected or required to learn as a result of some learning experience. *Assessment* is a systematic process of gathering information or evidence about student learning from a variety of sources (including assignments, demonstrations, projects, performances, portfolios, and tests) that accurately reflects how well a student is achieving expectations. As part of the assessment, teachers need to provide students with descriptive feedback that guides their efforts towards improvement. *Evaluation* refers to the process of judging the quality of student work on the basis of the Achievement Chart for Science (rubric), and assigning a percentage grade to represent the quality. This judgment is based on how well the student has met the course expectations and is *built on the highest, recent, consistent level of achievement.*

In order to ensure that students improve their learning and achieve success, assessment drives each activity throughout this course. As such, the assessment strategies are embedded within the instructional process throughout each unit rather than being isolated at the end. The assessment strategies and tools are summarized in a table at the beginning of each unit and are listed in the Teacher Facilitation section of each activity. Samples of the assessment tools are contained in the Appendices following each unit. Other tools include anecdotal comments, tests and quizzes, scoring templates, answering keys, written and oral comments.

The assessment strategies are situated to provide frequent and immediate feedback to the students on how they are progressing in their learning. Students who are taking this course have the greatest success when they receive immediate feedback. Formative assessment for these students is very important.
For example:

- Notebooks and Science Learning Logs should be assessed early and often in order to be improved and be used effectively.
- Students should always have opportunities to practise a skill with feedback/coaching before there is a summative assessment.
- Scoring tools, such as rubrics, should be developed with students or explained to them with exemplars to demonstrate a good product.
- Assessment should never be a *surprise*; it should be an obvious and planned part of their course.

Since assessment is to help improve student learning, it is important to ensure that how they will be assessed and evaluated is shared with the students beforehand. Making details of the assessment and evaluation process known to all students is a powerful way to promote student success in the achievement of expectations.

Numerous smaller assessments, using a wide variety of assessment tools provide students with different learning modalities and opportunities to demonstrate their level of achievement in different ways.

Quality of Assessment and Evaluation

- can be modified to accommodate a variety of learning styles;
- can be modified to accommodate special needs students;
- include both performance tasks and paper-pencil instruments;
- can be diagnostic, formative, or summative;
- are clearly linked to the expectations and to the Achievement Chart-Grades 9-10, Science;
- employ a wide variety of assessment tools and procedures;
- are used to improve learning, from the perspectives of the student and the teacher;
- are done on a regular basis providing frequent feedback to the student;
- are structured to provide the student with opportunities to be successful;
- provide judgments about student achievement from the four categories described in the Achievement Chart for Science;
- can involve both individual and group performance;
- employ a wide variety of tools and procedures;
- make the student a partner in the assessment process through helping to set criteria and through self- and peer-assessment;
- are criterion referenced, comparing student performance to set expectations, not to other students.

Reporting

Student achievement is reported as a percentage grade and should reflect the student's most-recent, highest, consistent level of achievement. Teachers need to have assessment data on each of the achievement categories (i.e., Knowledge/understanding, Inquiry, Communication, Making Connections) to evaluate the student's performance. For this course, teachers in a jurisdiction should confer on the weighting of the categories in the achievement chart when preparing final grades. Evaluation in this course would place higher weighting on the inquiry/skills category than in academic or applied courses.

In addition, The Ontario Report Card also requires that teachers report on five Learning Skills (Works Independently, Teamwork, Organization, Work Habits/Homework, Initiative). Teachers need to collect sufficient observations to document their evaluation of these five skills. Since these skills are not science expectations, the assessment of these skills would not be included in the science mark.
(Parts of the above were adapted from the *Public District School Board Writing Partnership Course Profile. Science, Grade 9, 1999, The Ontario Curriculum, Grades 9 and 10: Program Planning and Assessment (1999*), and *Guide to the Provincial Report Card, Grades 9 - 12*)

Resource Summary

A. General References on Education and Science Education

Bennett, Barrie, Carol Rolheiser, and Laurie Stevahn. *Co-operative Learning: Where Heart Meets Mind*. Toronto: Educational Connections, 1991. ISBN 0-9695388-0-4

Dalton, Susan and Mitchell O'Toole. *Science Exercises, Books 1, 2, and 3*. Richmond, Victoria: Heinemann Educational Australia, 1985.

Linderman, Bill. *Vocabulary Building with Word Searches*. Grand Rapids, MI: Instructional Fair, Inc., 1990.

O'Connor, Ken. *The Mindful School: How to Grade for Learning.* Arlington Heights, IL: Skylight Training and Publishing, 1999. ISBN 1-57517-123-6

Rogers, Spence and Shari Graham. *The High Performance Toolbox.* Evergreen, CO: Peak Learning Systems, 1998. ISBN 1-889852-07-4

Rogers, Spence, Jim Ludington, and Shari Graham. *Motivation & Learning: Practical Teaching Strategies and Tips*. Evergreen, CO: Peak Learning Systems. ISBN 1-889852-30-9

Zeman, Anne, and Kate Kelly. *Everything You Need To Know about Science Homework*. New York: Scholastic Inc, 1994.

B. General Science Texts or Resource Books

Bloch, Mars, et al. *Nelson Science 9*. Toronto: ITP Nelson, 1999.

Science Workshop Series. Softcover texts with a reading level of Grades 4-5 and an interest level of Grades 6-12. Globe Ferron. Annotated Teachers' Editions are available for all of the following:

- *Biology: Survey of Living Things*. ISBN: 0-835-90360-5
- *Biology: Human Biology.* ISBN 0-835-90365-6
- *Biology: Dynamic Processes.* ISBN 0-835-90374-5
- *Earth Science: The Universe.* ISBN 0-835-90388-5
- *Physical Science: Matter and Energy.* ISBN 0-835-90278-1
- *Physical Science: Chemical Changes.* ISBN 0-835-90284-6
- *Physical Science: Electricity and Magnetism.* ISBN 0-835-90286-2
- *Chemistry: Atoms and Elements.* ISBN 0-835-90312-5

Distasio, Joan. *Physical Science*. Grand Rapids, MI: Instructional Fair, Inc., 1994. ISBN 1-56822-188-6

Jacobson, Willard and Abby Bergman. *Science For Children, A Book for Teachers*. Englewood Cliffs, NJ: Prentice Hall, 1991. ISBN 0-13-794843-3

Vriesenga, Daryl. *Science Enrichment.* Grand Rapids, MI: Instructional Fair, Inc., 1994. ISBN 0-88012-914X

Wolfe, Elgin, et al. *SCIENCEPOWERä 9*. Toronto: McGraw-Hill Ryerson, 1999.

C. Periodicals

Science Scope - published by the National Science Teachers' Association (NSTA), Washington D.C.
SkyNews, The Canadian Magazine of Astronomy & Stargazing. Box 9724, Station T, Ottawa, ON K1G 5A3: National Museum of Science and Technology. ISBN 0840-8939 (bimonthly magazine)
Toronto Star (Sunday edition) has weekly columns on Science and The Universe (Terence Dickinson)

D. Science and Education Internet Sites (and sites that lead to them)

American Association for the Advancement of Science - http://www.aaas.org/

Canadian Space Agency Resource Centre - www.spacenet@eybe.edu.on.ca

Canadian Space Agency - www.space.gc.ca
National Science Foundation - http://www.nsf.gov/

Ontario Ministry of Education and Training - curriculum documents page - http://www.edu.gov.on.ca/eng/document/curricul/curricul.html

Science Teachers Association of Ontario (STAO) - http://www.stao.org/hotlinks.htm

USA National Academy of Sciences - http://www.nas.edu/

Bill Nye the Science Guy – http: //nyelabs.kcts.org/
Activities and information that are easy to use, interesting and fun

The Why Files - http://whyfiles.news.wisc.edu/
Explains the science behind current news items in an understandable way

Discovery Online - http://www.discovery.com/
Information and activities in areas including technology, nature, and science

NASA Spacelink for Educators - http://spacelink.nasa.gov/index.html
Aeronautics and space resource for educators; curriculum materials are directed at earth science, life science, physical science, math, space, technology, and careers

Smithsonian Institute - http://www.si.edu/newstart.htm
Source of research information on science and technology as well as book reviews both fiction and non-fiction

Ontario Institute for Studies in Education at the University of Toronto - http://www.oise.utoronto.ca/~science/
Science unit plans and lessons for new science courses

Science resource web site - http://www.davis.k12.ut.us/etc/Science.htm
Annotated list of web sites for science educators

Science Rubrics -
http://intranet.cps.k12.i1.us/assessments/Ideas_and_Rubrics/Rubric_Bank/ScienceRubrics.pdf
http://intranet.cps.k12.il.us/assessments/Ideas_and_Rubrics/ideas_and_rubrics.html

Appendices Overview:

Appendix OV-1: Science Learning Log Worksheet

(This is a template of an SLL which could have the vocabulary placed in a vertical column so that it easier to define. The template could also be placed on computer to assist students who learn better that way. The focus question(s) assists students to use the vocabulary to derive meaning of information from the activity. The connections section is a simple question or direction which guides students in reflection, making connections to the community, setting goals, asking new questions, or preparing for the culminating activity.)

Name: **Date:**

Unit/Topic:

Vocabulary:

Focus Question or Task:

Connection:

Complete the vocabulary, focus question(s), and connection then place it as an entry in your Science Learning Log

Appendix OV-2: Science Learning Log Rubric

This rubric describes your use of science words and ideas and how you connect them to other situations.

Categories	**Level 1** *Limited Performance*	**Level 2** *Inconsistent Performance*	**Level 3** *Good Performance*	**Level 4** *Excellent Performance*
Use of Scientific Vocabulary	- uses vocabulary words with limited accuracy and effectiveness (1 word used correctly)	- uses vocabulary words with some accuracy and effectiveness (2 or 3 words used correctly)	- uses vocabulary words with considerable accuracy and effectiveness (4 words used correctly)	- uses vocabulary words with a high degree of accuracy and effectiveness (all words used correctly)
Demonstrates an Understanding of Concepts	- demonstrates an understanding of a few required concepts taught with major errors or omissions	- demonstrates understanding of some of the required concepts taught with several minor errors or omissions	- demonstrates understanding of most of the required concepts taught with a few minor errors or omissions	- demonstrates an understanding of all of the required concepts taught. - any minor errors or omissions distract little from the correct concept
Communication of Required Knowledge	- communicates poorly, making many errors or omissions. - audience is unable to gain a picture of what is intended. - rarely uses appropriate terminology	- communicates with some clarity, making some errors or omissions. - audience is distracted from a clear understanding by the errors made. - sometimes uses appropriate terminology	- communicates clearly and precisely, making few errors or omissions. - audience may be slightly distracted by errors. - usually uses appropriate terminology	- communicates clearly and precisely, making no, or almost no, errors or omissions. - any errors do not distract the audience from understanding - uses appropriate and varied terminology

Categories	**Level 1** *Limited Performance*	**Level 2** *Inconsistent Performance*	**Level 3** *Good Performance*	**Level 4** *Excellent Performance*
Making Connections	- makes simple connections to own life - shows limited understanding of connections in familiar contexts - reflection may lead to simple questions with no suggestions for how to find answers	- makes some connections to own life - shows some understanding of connections in familiar contexts - reflection leads to simple additional questions but pathway to find answers is vague or limited	- makes connections to community, world at large, or workplace - shows considerable understanding of the connection in familiar and some unfamiliar contexts - reflection leads to additional questions on the topic some suggestions on how to obtain answers or reach a goal	- makes a variety of connections to the community, world at large or workplace - shows thorough understanding of connections in familiar and unfamiliar contexts - reflection leads to additional questions on topic with clear avenues to follow to obtain answers or reach goal
Impact	- assesses the impact (environmental, social, economic) of actions or courses of action with limited effectiveness	- assesses, with some analyses, the impact (environmental, social, economic) of actions or courses of action with moderate effectiveness	- assesses or analyses the impact (environmental, social, economic) of actions or courses of action with effectiveness	- assesses or analyses the impact (environmental, social, economic) of more complex actions or courses of action with considerable effectiveness

Appendix OV-3: Co-operative Small Group Learning / Description and Structures

What Is Co-operative Learning?

Co-operative Small Group Learning (CSGL) or "Co-operative Learning" is an instructional strategy in which students work in small groups or teams to help one another master a skill or academic material. Co-operative learning has been widely researched and effectively used in a wide variety of school classrooms. Classroom activities are organized so that students work together to learn from one another as well as from the teacher and the world around them. Built into the strategy are methods of increasing social skills and taking responsibility for one's own learning.

Size and Selection of Groups

Students work in groups. *To be effective, the group has to be small enough so that all members can contribute to the task.* The maturity and skill of the students, class size, size of your facilities, and complexity of the task all have a bearing on the group size chosen. Time is also a factor; the shorter the time to complete the task, the smaller the group should be.

Start out with small groups when introducing co-operative learning to students with little experience in this strategy. As the teacher and students become more skilled, the size of the group can increase. Groups of 2 or 3 are best until students become skillful at including everyone. Groups should never be larger than groups of 5 or 6. *Remember the larger the group, the more sophisticated the students' social skills have to be and the simpler the group's task has to be.*

The more heterogeneous the class, the more necessary it is that the teacher select the members of the groups. Each group should have a mix of abilities, sexes, language skills, ethnocultural groups and motivational levels. "Friendship groups" chosen by the students tend to be homogeneous and also can become cliquish and cause the students to stray from the task. Taking the time to provide a rationale for working with a wide variety of people in the classroom decreases chances that students might protest their group placement.

Several CSGL structures are suggested as teaching strategies in this unit. The use of these structures is made easier if the students master one structure at a time. Each strategy has five basic elements built in.

Five Basic Elements of Co-operative Learning

1. **Positive Interdependence:** All members of the team feel connected to one another in the accomplishment of a common goal. All individuals must succeed for the group to succeed. Other members of the team value individual student effort. Ways of building in *positive interdependence* include having one product from the team, providing one instruction sheet per team, ensuring that each member has an assigned role in the team activity, and working at a single table or station.

2. **Individual Accountability**: Every member of the team is held accountable to demonstrate accomplishment of the learning. Students are responsible both for their own learning as well as for the learning of other members of the team.

3. **Face-To-Face Interaction**: Students must be in close proximity to each other. Talk is the way people explore ideas, clarify them, and personalize information and experience. Students learn buy having ample opportunity for purposeful talk.

4. **Social Skills**: Working collaboratively requires the use of co-operative skills. Skills such as taking turns, encouraging, listening, giving help, clarifying, checking, understanding, and probing enhance communication, trust, leadership, decision making, and conflict management. Co-operative Small Group Learning helps students learn these skills.

5. **Group Processing**: Built into this strategy is time for team members to assess their collaborative efforts (How well they have achieved their social skill?) and target improvements. To debrief the collaborative effort in the activity, ask students to reflect privately on how their team did and how they might improve it if the activity was repeated. Have them share their rating with the rest of the team and briefly discuss how the social skill could be improved. This reflective element allows co-operative interactions between team members which improves future group activities.

Social Skills Have To Be Taught

For each co-operative learning activity there should be not only an academic skill objective, but a social skill objective. Sometimes the students need to identify the social skill. In identifying expectations for the group, the teacher might say: *"I expect to see everyone staying with the group", "using quiet voices", "contributing ideas", "asking for help if it is needed", "listening carefully to other group members", "encouraging all group members", "making certain that everyone is included in the work", "and making certain that everyone understands and agrees."* Only one social skill, or at most two, should be focused on in a lesson.

The teacher should assist students in understanding why they are learning the social skill, what the skill is, ways the skill can be practised during the activity, and how well the group used the skill and how they can improve their own use of the skill (part of Group Processing)

The social skills that the students need to work on collaboratively have to be taught. One way of teaching a social skill might be beginning with a T-chart. A T-chart answers the questions:

What should one see?	*What should one hear?*

Some Co-operative Small Group Learning Structures

1. **Brainstorming** is used to accumulate the collective information held by the entire group. There are a number of brainstorming techniques. Graffiti is one of these ways. The next step after brainstorming could include categorizing or summarizing the data students have collected. The following rules improve this process:

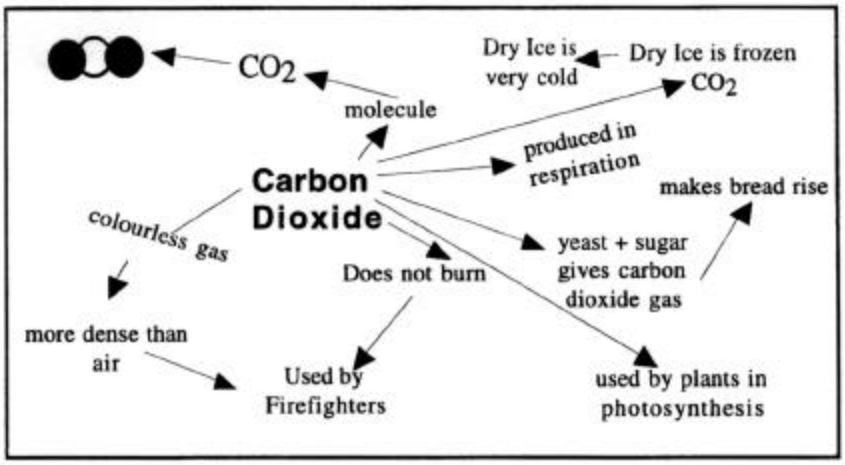
DOVE Rules For Brainstorming

- **D**efer judgment —accept all ideas, list everything, and evaluate later.
- **O**pt for original and offbeat, anything goes, especially different and crazy ideas.
- **V**ast numbers of ideas are best —get many ideas, the more the better.
- **E**xpand by association —piggyback off each other's ideas, substitute ideas, combine ideas.

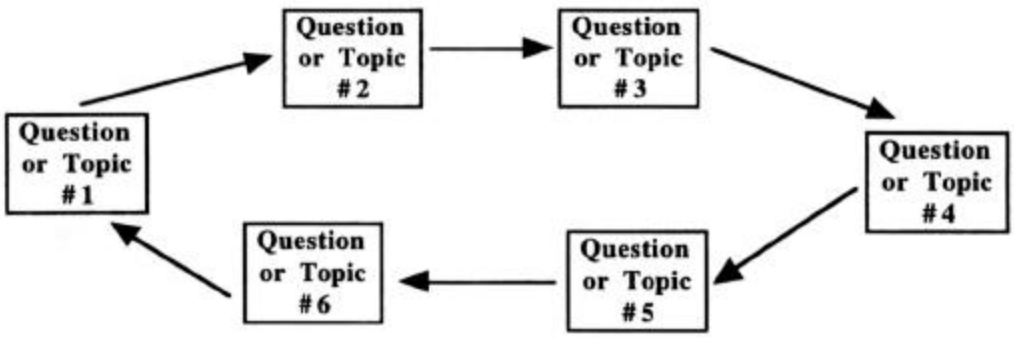
Graffiti is a co-operative small-group learning structure that can be used as an energizer and facilitates brainstorming. It is a suggested teaching/learning strategy in Activity #1. The students are creating a mindmap as a record of their work. The purpose of the product (mind map) is to provide the teacher with the opportunity to assess prior learning while allowing the students to reestablish some concepts, skills and vocabulary.

Procedure for Graffiti

1. Teacher outlines the DOVE rules of brainstorming and why they are used.
2. Students are put in teams of three or four.
3. Each member of one team has a marker of the same colour for tracking each group's contribution. Each team has one large piece of chart paper or butcher paper.
4. Each team is given a different question, topic, issue, or statement to which they respond.
5. Briefly demonstrate what is meant by a mind map and recording a variety of ideas as words, graphics, phrases



6. For a short period of time each team in the room writes their graffiti (words, phrases, graphics) about their topic or issue.
7. Each team then passes their graffiti sheet to the next team, who then add their ideas to it.



8. Continue to rotate until all teams have added to each sheet.
9. When the graffiti sheet returns to the originating team, they read, discuss, and summarize or categorize all of the information on their sheet. Each group selects a reporter.
10. Share this information with other groups by having a "gallery walk" to quickly look at the different posted sheets, then give an oral presentation.
11. Have each group debrief their 'social skill' and how they might improve the next time.
12. Have each student make a summary record in his/her personal science log.

A Sample Learning Log Entry
Academic Task: To brainstorm using a Graffiti co-operative learning structure to record all the words, phrases, ideas, or graphics on the topic on your chart paper.

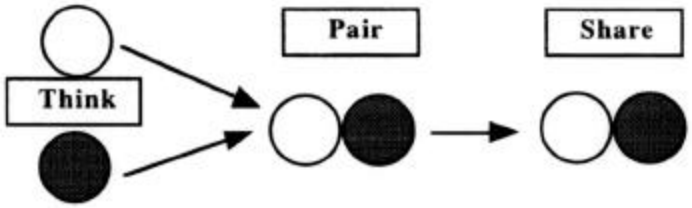
Social Skill: The social skill that you are working on as a team during this activity is *"encouraging, accepting, and valuing the opinions of other members of your team"*.

T-Chart: "What should I see?" and What should I hear?" if you are working successfully on this social skill.

Gallery Walk: Students do a tour to read the posted sheet and make personal notes for their learning logs. This could also include each original team reporting as part of the gallery walk or having a docent (student explainer) at each poster to answer questions and explain the team's posted ideas.

2. **Turn To Your Partner:** Students work in pairs. During the lesson, the teacher asks students take turns posing examples, explaining a concept just taught, providing examples, coming up with an answer, etc. In this way, all teams are focused on the problem and not just the single student who is called upon to answer the question. Active processing reinforces concept understanding and retention.

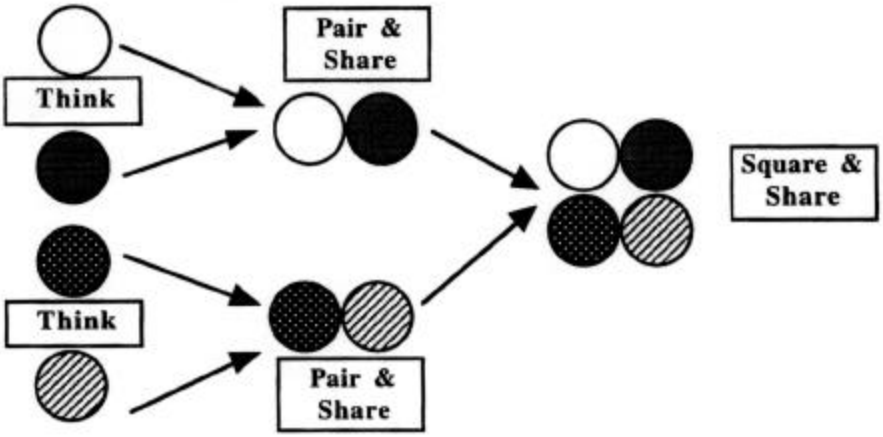
3. **Think-Pair-Share**: This is a simple structure that can be implemented quickly and can be used to actively involve all the students. It is a quick way to reinforce learning (i.e. explain observations to one another, consider a question posed by the teacher, review a homework assignment). Research has shown that this immediate processing of information moves the concept from short-term memory to long-term memory.



Procedure for Think-Pair-Share

1. Teacher outlines the social and academic skills. The social skill is often *listening carefully* to your partner's answer.
2. Students formulate an individual answer to the academic task for a given amount of time, and if necessary make rough notes.
3. Students pair and share their answer with a partner. Each student listens carefully to his or her partner and then creates a new or final answer through discussion.
4. A member of one or several groups reports to the whole class (Tell us one important use of the sun's energy.")
5. Students make a record in their learning log.

4. **Think-Pair-Square** is a variation on the above where the audience is another pair. For example, each group lists three things members think they know about photosynthesis and one question they have. Groups combine to put their lists together.



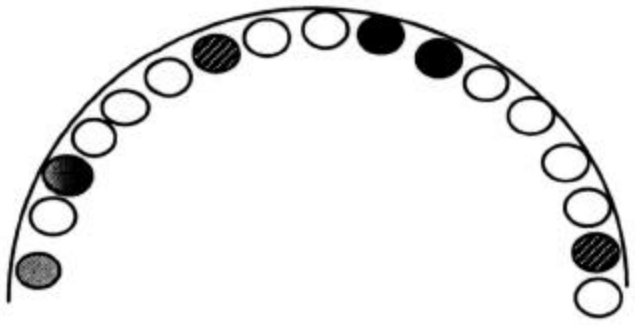
5. **Flip It:** Students work in pairs. One partner explains to the other a concept selected by the teacher. On the instruction of "flip it," the partners reverse roles. This increases listening skills dramatically. Flip it can be used for reviewing, rehearsing, or checking for understanding.

6. **Roundtable:** Students work in groups of four. Each group has only one pen and one piece of paper. The teacher poses a question which is already written on the paper. Each student writes one line of the solution and then passes the paper to the next student. Students have the right to 'pass' a turn. This structure can also be used to review several questions where the student gets to fill in the space of his/her choice before passing the paper onto the next student. With simultaneous roundtable, more than one paper and pencil are passed around the group.

7. **Round Robin:** This is similar to Roundtable except that it is verbal instead of written. Each student in turn shares something with his or her teammates. (Students have the right to 'pass' a turn.) This is a good activity for equal participation or getting acquainted with teammates. It can be used to express ideas and opinions, to complete simple tasks such as labels on a diagram.

8. **Numbered Heads Together:** Students work in numbered groups of four. The teacher asks a question or poses a problem. Students put their "heads together" to make certain that everyone in the group knows the answer. The teacher calls a number (1, 2, 3, or 4) and students with that number raise their hands to respond. This tutoring method is good for reviewing, checking for knowledge and comprehension. Positive interdependence and individual accountability are built into the structure. If any student knows the answer, the ability of each student is increased. All the helping is confined to the heads-together step; students know that once a number has been called students are on their own. The high achievers share answers because they know their number might not be called and they want their team to do well. The low achievers listen carefully because they know their number might be called and the group is dependent on them.

9. **Wraparound** is a co-operative learning structure that has a very strong individual accountability element built in. Ten to fifteen students sit in a semicircle. The teacher establishes the task (centre) for the cognitive map (i.e. a healthy fetus). The activity starts with any student in the semicircle adding a word or phrase to the map. The recorder, who could be the teacher, writes this on the chalkboard or chart paper. The next person in the circle has to piggyback an offshoot idea to the first addition or add another main idea to the map. Students have the right to "pass" if they do not have an answer. Wraparound may start a bit slowly, but once several ideas have been written down the association/piggyback effect begins and very few students find it necessary to pass.



Higher order and creative thinking can be nurtured by having students connect the ideas and explain whether an idea is a main one or an offshoot.

The social or collaborative skill is building on the ideas of others. Listening, reading, and critical thinking skills are involved.

10. **Jig Saw** is a sophisticated CSGL structure that is best not used until students have mastered co-operative learning as a strategy in simpler structures. Each student on the home team becomes an "expert" on one topic by working with members from other teams assigned the corresponding expert topic. Upon returning to their home team, each person in turn teaches home team members and the students are assessed on all aspects of the topic. This structure requires considerable planning and emphasizes positive interdependence.

Some CSGL References:

Bennett, Barry, Carol Rolheiser-Bennett, and Laurie Stevahn. *Co-operative Learning: Where Heart Meets Mind*. Toronto: Educational Connections, 1991. ISBN: 0-9695388-0-4

Clarke, Judy, Ron Wideman, and Susan Eadie. *Together We Learn*. Scarborough: Prentice Hall Canada, 1990. ISBN: 0-13-924556-1

Johnson, D.W., R.T. Johnson, and E.J. Holubec. *Cooperation In The Classroom* (rev. ed.). Edina: Interaction Book Company, 1991. ISBN 0-939603-04-7

Appendix OV-4: Rubric for Collaborative Group Work

This rubric outlines how effectively you work with others and contribute to producing a quality product

Criteria	Level 1 Performance	Level 2 Performance	Level 3 Performance	Level 4 Performance
Interpersonal Skills in Group Work	- disruptive in group, even after behavior prompts, and expressed opinions which are insensitive to others' feelings and abilities	- interacts with other group members if prompted, but sometimes expresses opinions which are insensitive to the abilities and feelings of others	- interacts with all group members spontaneously and contributes in a way that is sensitive to the abilities and feelings of others	- interacts positively with all group members, encourages such interaction in others, and is always sensitive to the abilities and feelings of others
Participation to Achieve Group Goals	- shows little commitment to group goals and fails to identify roles or perform assigned roles	- demonstrates commitment to group goals, but has difficulty performing assigned roles	- demonstrates commitment to group goals and carries out assigned roles effectively	- actively helps to identify group goals and works effectively to meet them in all roles assumed
Contribution to Group Maintenance	- cannot identify changes needed in group processes, and is unwilling to participate in making those changes identified by others	- identifies changes needed to improve group processes if prompted, and is minimally involved making those changes	- identifies and helps to make adjustments needed in group processes to maximize group effectiveness	- actively works to identify and carry out changes in group processes necessary to maximize group effectiveness
Roles Performed in the Group	- is limited in inclination or ability to perform roles in the group even after they are identified	- willing and able to perform some group roles effectively, once they are assigned	- sees the need for roles, but has some difficulty in identifying all of them and is willing and able to perform most group roles effectively	- identifies necessary roles, volunteers to perform any group role, and does so effectively and creatively

(Parts of the above chart were adapted from the Public District School Board Writing Partnership, *Course Profile. Science, Grade 9 Applied*)

Appendix OV-5: Notebooks Are Important!

Name _____ Date_____

This is a rating scale for your science notebook. Use it as a guide to improve your recording.

1. Index/Table of Contents is complete 0 1 2

2. All pages are numbered and dated 0 1 2

3. Notes are sequenced correctly 0 1 2

4. Notebook has a neat organized appearance 0 1 2
(attractive appearance, headings underlined, notes spaced out, written in ink, writing is legible, care has been taken to make a quality product)

5. All notes/lab reports/worksheets have been completed and corrected 0 1 2 3 4
Except _____

_____
(complete these as soon as possible)

6. Science Learning Logs have all been included 0 1 2

7. Entries/questions in each Science Learning Log have been completed 0 1 2 3

8. Notes have headings and subheadings which indicate the content 0 1 2

9. Diagrams and graphs are well done 0 1 2 3 4
(neat , large enough, done in pencil, labeled)

10. Tests and quizzes have been corrected 0 1 2

11. Homework has been completed and corrected 0 1 2

12. Spelling and grammar are above average 0 1 2

Comments:

This notebook rating scale is part of your notes.
Please keep this page just after the portion of notes that has been assessed.

Appendix OV-6: Summary of The Ontario Curriculum, Grades 1 - 8: Science and Technology

Strand	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Life Systems	**Characteristics and Needs of Living Things**	**Growth & Changes in Animals**	**Growth & Changes in Plants**	**Habitats & Communities**	**Human Organ Systems**	**Diversity of living Things**	**Interactions Within Ecosystems**	**Cells, Tissues, Organs & Systems**
Key words	body parts & functions, diet, movement, senses	comparisons, life cycles, behavioral characteristics	parts & functions, classification, life cycle, features for survival	food chains, structural adaptations, classification	cells, organ interactions, diet, lifestyle	classification systems, pond study	biotic and abiotic factors, food webs, nutrient cycles, biomes	unicellular & multicellar (plants & animals), diffusion, osmosis
Investigations	predict how an animal will move	link teeth shape to function	seed germination or plant growth study (onset of wilting, build a terrarium	habitat assessment	system studies (response time, impact of orthotics)	impact of food manipulation on insect growth	community changes & impact on plant/animal populations	effect of chemicals on protists, flower wilting prevention
Equipment	field microscope, magnifier	magnifier		magnifier		magnifier, microscope	field microscope, magnifier	field microscope, microscope
Matter & Materials	**Characteristics of Objects & Properties of Materials**	**Properties of Liquids & Solids**	**Magnetic & Charged Materials**	**Materials That transmit/Reflect/Absorb Light/Sound**	**Properties of Changes in Matter**	**Properties of Air & Characteristics of Flight**	**Pure Substances & Mixtures**	**Fluids**
Key words	physical properties, Classification, use of senses	solubility, physical states, buoyancy, viscosity	polarity, electrostatics, conductor, insulator	sources, clarity, prisms, colour theory	changes of state, physical and chemical changes, pressure	gravity, aerodynamics, sources of propulsion	particle theory, heterogeneous & homogeneous, saturation, solubility	hydraulic & pneumatic devices, viscosity, density, Archimede's Principle, gravity
Design/ Construct	usable product (aesthetically pleasing)	buoyant object	system moved by magnets	instruments for specific purpose	product that minimizes heat loss	test structure that flies, device using pneumatic power	flowchart for manufacturing a product	system that uses pneumatic or hydraulics (model), hydrometer
Investigations	manipulation of materials for sound production & comparative studies	comparison of buoyancy, absorbency & reactions	magnetic strength & friction	material properties & sound or light transmission	product assessment, rates of gas production, changes of state	Bernoulli's Principle	saturated solutions & temperature variation, mixture separations, water testing	viscosity & temperature, m/V relationship, buoyancy/gravity relationship
Equipment	magnifying glass		bar & rumen magnets, compass	ray box	balance, hot plates, graduated cylinder, thermometer	clinometer, propellers	balance, graduated cylinder, separation equipment	balance, graduated cylinder, overflow can, thermometer

Strand	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Energy & Control	**Energy in Our Lives**	**Energy From Wind & Moving Water**	**Forces & Movement**	**Light & Sound Energy**	**Conservation of Energy**	**Electricity**	**Heat**	**Optics**
Key words	sun, food, consumption & conservation	renewable, hydroelectricity, windmills, water wheels	directional & gravitational forces, magnetism & electrostatics	sources, properties, shadows, pitch, human ear	non-renewable, natural resources, energy forms	circuits, energy transformations & consumption	Particle Theory, water cycle, heat capacity	sources of light, reflection, colour theory
Design/ Construct	manually controlled device (i.e. fan), poster of energy forms	device propelled by air, device that controls flow of water and/or air	device that uses a specific form of energy	optical device, musical instrument	device that transforms energy	electrical circuits (operates a device), plan to reduce energy consumption	device that minimizes heat transfer	research brochure (i.e. risks of radiation)
Investigations	alternatives in case of power failure, impact of senses on energy use	effect of wind direction and wind speed on the devices	forces affecting speed or direction of moving object	behaviour of light with various optical devices	stored energy, local recycling programs	converting chemical to electrical energy	factors affecting heat transfer	investigate light properties & reflection
Equipment	radiometer, potato clock		magnets, iron filings	tuning fork, sound level meter, mirrors, prisms		hand generator, circuitry equipment	ball & ring, bimetallic strip, conductometer, hot plate, thermometer	curved mirrors, laser, lenses, prism, ray boxes
Structures & Mechanisms	**Everyday Structures**	**Movement**	**Stability**	**Pulleys & Gears**	**Forces Acting on Structures/ Mechanisms**	**Motion**	**Structural Strength & Stability**	**Mechanical Efficiency**
Key Words	shapes, patterns, actions & responses	hinge, inclined plane, wheel, axle, lever, wedge	loads, fulcrum, forces, levers, struts, ties	rotary motion, one to two planes (gears), tension, levers	load-bearing tension & compression, torque	linear, rotational, reciprocating, oscillating, levers & fulcrum friction	solid, frame or shell structures, centre of gravity, loads	hydraulic & pneumatic power, Pascal's Law, velocity, friction
Design/ Construct	structure (explain its function)	device using mechanisms	stable structure to support a mass (bridge/photo frame), levered structure & stable structure with a mechanism	a pulley system that performs a task, a system of pulleys	frame structure that supports a load (bridge), mechanical system with a function	mechanical device that changes direction & speed of input (clothesline)	work plan outlining resource choice for product manufacturing	mechanical system operated by hydraulic or pneumatic power
Investigations	occurrence of various shapes, equipment shape & function	factors affecting the movement of a load	impact of fulcrum position	impact of tension on pulleys, compare gear systems, modify devices built	effect of changing a pulley system to a lever system	measuring motion of moving objects, reducing friction	performance of a structure (mass versus load support)	measure forces that affect movement (friction)

Strand	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Earth & Space Systems	**Daily & Seasonal Cycles**	**Air & Water in the Environment**	**Soils in the Environment**	**Rocks, Minerals & Erosion**	**Weather**	**Space**	**The Earth's Crust**	**Water Systems**
Key Words	temperature, wind light, plant & animal adaptations	physical properties, water cycle, weather	animal & plant life, root types, recycling (decomposition)	physical properties, classification, impact of human activities	major climatic factors & patterns, clouds, water cycle, barometric pressure	solar system, eclipses, constellations, earth rotations (seasons)	plate tectonics, fossils, strata rock cycle, soil formation	impact on climate & weather, various states, salt & fresh water systems
Design/ Construct	model of a structure for protection against weather conditions	instructions for constructing a pinwheel	useful clay models (i.e. Brick)	fossil mould to make replicas	model of a cloud in a jar, various weather instruments (and test them)	device to tell time (sundial)	models (i.e. volcanoes, time scale for earth formation or mining techniques)	compare density of various objects & their buoyancy in fresh or salt water
Investigations	changes in outdoor temperatures, sun position & shadow creation or flower movement	cloud study (indicator of weather changes), fabric caparison (drying times)	soil separation, water absorption by various soil types	erosion of various sand structures	compare fabrics (water proofing and insulating fabrics)			
Equipment			sieves					thermometers

(Chart prepared by the science writing team for the Public District School Board Writing Partnership, *Course Profile, Science, Grade 9, Applied*. The chart summarizes activities by strand and grade in *The Ontario Curriculum, Grades 1-8, Science and Technology (1998))*

Coded Expectations: Essential Science, Grade 9

Biology: Cells and Reproduction

Overall Expectations

BYV.01
– demonstrate an understanding of how cell division explains growth and reproduction of an organism;
BYV.02
– conduct investigations into cell division and reproduction;
BYV.03
– describe ways in which knowledge of cell division and reproductive technologies are used in the workplace.

Specific Expectations

Understanding Basic Concepts

BY1.01
- distinguish between living and non-living things (e.g., using the criteria of respiration, digestion, excretion, and cellular composition);
BY1.02
– describe, using their observations, differences in structure between plant and animal cells (e.g., presence or absence of cell wall, size and number of vacuoles, presence or absence of chloroplasts, size and shape of cells);
BY1.03
– describe the organization of cells into tissues, organs, and systems (e.g., the digestive system);
BY1.04
– recognize that cells in multicellular organisms need to reproduce to make more cells to form and repair tissues (e.g., healing a cut);
BY1.05
– demonstrate an understanding of the importance of cell division to the growth and reproduction of an organism (e.g., conception, role of chromosomes, growth of a baby, uncontrolled cell division leads to cancer);
BY1.06
– compare sexual and asexual reproduction in general terms (e.g., requirement for a partner, suitability of environmental conditions such as food, warmth, and moisture);
BY1.07
– recognize signs of pregnancy in humans and describe the major stages of human development from conception to early infancy (e.g., trimesters).

Developing Skills of Inquiry and Communication

Through investigations and applications of basic concepts:

BY2.01A
– formulate scientific questions about cell division and reproduction;
BY2.01B
- demonstrate the skills required to conduct an inquiry using instruments and tools safely, accurately, and effectively (e.g., use a microscope at an appropriate level of magnification to locate and view cell division on a slide);

BY2.01C
– select information from various sources to answer the questions chosen;
BY2.01D
– organize, record and analyze the information gathered;
BY2.01E
– communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats;
BY2.02
– use a microscope accurately to find, observe, and draw microscopic objects (e.g., examination of cheek, elodea, onion cells; examination of live amoeba, daphnia, paramecium; preparation, examination, drawing and labeling of specimens in wet and dry mounts).

Relating Science to Technology, Society, and the Environment
BY3.01
- evaluate how environmental factors can influence cell division in a tissue or fetal development (e.g., smoking during pregnancy, use of sunscreen at the beach, X-rays);
BY3.02
– describe the use of reproductive technologies in a workplace or home environment (e.g., use of yeast in a bakery; bacterial culture in yogurt; root, stem and leaf cuttings; grafting).

Chemistry: Substances and Their Uses

Overall Expectations
CHV.01
- describe and represent common elements and compounds;
CHV.02
- investigate the properties of common elements and compounds;
CHV.03
- demonstrate an understanding of the importance, use, and environmental hazards of common elements and compounds.

Specific Expectations
Understanding Basic Concepts
CH1.01
- recognize that substances are identified by their properties;
CH1.02
– recognize that both compounds and elements are pure substances but only compounds can be broken down into simpler substances;
CH1.03
– describe the difference between molecules and atoms;
CH1.04
– write and identify symbols for some common elements (e.g., H, C, N, O, Cl, Fe, Al, Na);
CH1.05
- interpret chemical formulae in terms of the number of atoms of each element present in the molecule (e.g., H_2O, CO_2, CO);
CH1.06
– classify common elements as metals or non-metals;

CH1.07
– classify changes in substances as either physical or chemical;
CH1.08
– describe, using their observations, the evidence for chemical changes (e.g., energy change, formation of a gas or precipitate, change in colour).

Developing Skills of Inquiry and Communication
Through investigations and applications of basic concepts:
CH2.01A
– demonstrate knowledge of laboratory, safety, and disposal procedures while conducting investigations (e.g., wear safety glasses; practice orderliness and cleanliness; follow WHMIS guidelines and emergency procedures; use proper procedures for handling, storage, and disposal);
CH2.01B
– formulate scientific questions about a problem involving the properties of substances;
CH2.01C
– demonstrate the skills required to conduct an inquiry into the properties of substances, using apparatus and materials safely, accurately, and effectively (e.g., investigate the properties of some common elements and compounds);
CH2.01D
– select information from various sources to answer the questions chosen;
CH2.01E
– organize, record and analyze the information gathered;
CH2.01F
– communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats (e.g., present data on different substances in a table using appropriate headings such as *compound, element, properties*);
CH2.02
- investigate, by laboratory experiment or classroom demonstration, changes in substances and classify them as physical or chemical (e.g., effect of heat on a variety of substances);
CH2.03
– conduct experiments on simple synthesis reactions (e.g., the synthesis of magnesium oxide);
CH2.04
– investigate, by laboratory experiment or classroom demonstration, a decomposition reaction and identify the elements produced (e.g., electrolysis of water);
CH2.05
– investigate the metallic and non-metallic properties of some common elements (e.g., magnesium, carbon, sulphur).

Relating Science to Technology, Society, and the Environment
CH3.01
- identify uses of elements in everyday life (e.g., iron, aluminum, oxygen, chlorine);
CH3.02
- explain how properties of substances influence their use (e.g., use of water as a solvent);

CH3.03

- describe examples of elements and compounds and the mixing of these substances which create environmental hazards (e.g., chlorine, sulphur dioxide, lead, nitrogen dioxide, lead solder is no longer used in water pipes, bleach and window cleaner should not be mixed);

CH3.04

- identify and describe appropriate careers or hobbies where knowledge of chemistry is important (e.g., cosmetologist, firefighter, choice of lakes and fishing).

Physics: Electrical Applications

Overall Expectations

PHV.01

– describe the characteristics of electricity;

PHV.02

– build and test electrical circuits using a simple plan;

PHV.03

– explain some of the practical uses of electricity and its impact on everyday life.

Specific Expectations

Understanding Basic Concepts

PH1.01

- identify electrons as the only fundamental component of an atom that can move;

PH1.02

- explain common electrostatic phenomena (e.g., clothes that stick together, attraction of hairs to combs, lightning);

PH1.03

- describe current electricity as the continuous motion of electrons;

PH1.04

- investigate several energy transformations that involve electricity (e.g., chemical to electrical in a battery, light to electrical in solarivcells, electrical to heat in an electric kettle);

PH1.05

- identify different circuit components and their standard symbols (e.g., ammeter, wire, switch, power source);

PH1.06

- explain how electric current, potential difference, and resistance are measured using an ammeter and a voltmeter (e.g., ammeter connected in series, voltmeter connected in parallel).

Developing Skills of Inquiry and Communication

Through investigations and applications of basic concepts:

PH2.01A

- demonstrate knowledge of electrical safety procedures when carrying out investigations and using materials, tools, and equipment (e.g., check wire insulation before plugging in a power pack);

PH2.01B

- formulate scientific questions about electricity (e.g., why do all of the decorative lights on a tree go out if one bulb is removed from some strings and not others?);

PH2.01C

- demonstrate the skills required to conduct an inquiry into the use of electricity, using instruments, tools, and apparatus safely, accurately, and effectively (e.g., build a series circuit using a standard wiring diagram and test the circuit for current when the potential difference is varied);

PH2.01D

- select information from various sources to answer the questions chosen;

PH2.01E

- organize, record, and analyze the information gathered (e.g., relate the brightness of each bulb, in a series circuit, to the number of bulbs in the circuit);

PH2.01F

- communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats (e.g., sharing ideas in small groups; demonstration of circuit assembly; structured laboratory reports);

PH2.02

- draw, and construct series and parallel circuits that perform a specific function (e.g., given light bulbs, wires, and batteries, produce circuits with: one light bulb on; two light bulbs of the same brightness; one light bulb disconnected and the other light bulb on);

PH2.03

- construct an electrical system that operates a device in a controlled way (e.g., a switch provides a controlled input, and lamps, buzzers, or motors produce the output).

Relating Science to Technology, Society, and the Environment

PH3.01

– describe and explain household wiring and its typical components (e.g., parallel circuits with switches, fuses, circuit breakers, outlets);

PH3.02

– describe ways to conserve electrical energy;

PH3.03

– identify and describe appropriate careers or hobbies where knowledge of electricity is important (e.g., small appliance repair, electrical assistant, sound and light crew).

Earth and Space Science: Space Exploration

Overall Expectations

ESV.01

– demonstrate an understanding of the structure and nature of our solar system and of the universe;

ESV.02

– conduct investigations into the appearance and motion of visible celestial objects;

ESV.03

– describe how human endeavours and interest in space have contributed to advancement of technologies in other fields and identify Canadian contributions to space exploration.

Specific Expectations

Understanding Basic Concepts

ES1.01

- recognize and describe the major components of our solar system (e.g., the names, the relative sizes and relative distances of the planets);

ES1.02
– recognize that our solar system is only a small part of the Milky Way Galaxy, which is only a small part of the universe;
ES1.03
– describe, compare, and contrast the characteristics and motions of the major components of the solar system (e.g., the state, rotation of the Sun, planets, moons, asteroids, comets);
ES1.04
– describe the Sun and its effects on life on the planet (e.g., the Sun as an energy source for photosynthesis, photovoltaic generators).

Developing Skills of Inquiry and Communication
Through investigations and applications of basic concepts:
ES2.01A
- formulate scientific questions about space exploration (e.g., time required for information to be transferred from the Hubble telescope to Earth);
ES2.01B
- demonstrate the skills required to conduct an inquiry on the motion of visible celestial objects, using instruments, tools, and apparatus safely, accurately, and effectively (e.g., graph sunrise and sunset data and relate it to the motions of the Earth);
ES2.01C
– select information from various sources to answer the questions chosen;
ES2.01D
– organize, record, and analyze the information gathered;
ES2.01E
– communicate scientific ideas, procedures, results, and conclusions using appropriate language and formats (e.g., prepare a comparative data table of various planets);
ES2.02
– gather, organize, and record data through regular observations of the night sky and/or use of appropriate software programs, and use these data to identify and study the motion of visible celestial objects (e.g., track the position of the Moon over time).

Relating Science to Technology, Society, and the Environment
ES3.01
– describe examples of how space research has affected our lives (e.g., global positioning system, (GPS), satellite dishes, dried foods such as Tang, graphite low-density material);
ES3.02
– research how Canada has contributed to space explorations (e.g., Canadarm I and/or Canadarm II, astronauts);
ES3.03
– describe careers and/or hobbies in science and technology that are related to the exploration of space, and identify the knowledge and skill requirements of such careers (e.g., machining of parts for robots, science fiction illustrator; using star charts and telescopes).