Final Draft

This Science Grade 10 document has been provided to assist school districts, schools, and teachers in preparing to deliver Science Grade 10 in 2008/2009, the first of year of prescribed implementation. Feedback on this draft is not required. Although this document is provided as draft material, it is anticipated the final Grade 10 Science curriculum will be consistent with this draft.

The information contained in this document supersedes the information re Grade 10 Science contained in the Science 8 to 10 Integrated Resource Package 1996. The entire updated Grade 8-10 curriculum is being implemented according to the following implementation schedule: September 2006 for grade 8; September 2007 for grade 9; September 2008 for grade 10.

SCIENCE GRADE 10

Integrated Resource Package 2006
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Many people contributed their expertise to this document. The Project Manager was Mr. Waël Afifi of the Ministry of Education, working with other ministry personnel and our partners in education. We would like to thank all who participated in this process.

**SCIENCE 8 TO 10 IRP WRITING TEAM**

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<thead>
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<th>Name</th>
<th>School District</th>
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<tbody>
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<td>School District No.71</td>
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GT Publishing Services, Ltd.  project coordination, writing, and editing
This Integrated Resource Package (IRP) provides information teachers will require in order to implement Science 8 to 10. This document supersedes the Science 8 to 10 Integrated Resource Package 1996, according to the following implementation schedule: September 2006 for grade 8; September 2007 for grade 9; September 2008 for grade 10.

The information contained in this document is also available on the Internet at www.bced.gov.bc.ca/irp/irp.htm

The following paragraphs provide brief descriptions of the components of the IRP.

INTRODUCTION

The Introduction provides general information about Science 8 to 10, including special features and requirements.

Included in this section are
- a rationale for teaching Science 8 to 10 in BC schools
- information about graduation program requirements and provincial examinations
- goals for Science 8 to 10
- information about the revision process that led to the publication of this document
- descriptions of the curriculum organizers—groupings for Prescribed Learning Outcomes that share a common focus
- Aboriginal content in the science curriculum
- suggested time allotments for each course
- a graphic overview of the curriculum content from K to 10

CONSIDERATIONS FOR PROGRAM DELIVERY

This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners.

PRESCRIBED LEARNING OUTCOMES

This section contains the Prescribed Learning Outcomes. Prescribed learning outcomes are the legally required content standards for the provincial education system. They define the required attitudes, skills, and knowledge for each subject. The learning outcomes are statements of what students are expected to know and be able to do by the end of the course.

STUDENT ACHIEVEMENT

This section of the IRP contains information about classroom assessment and measuring student achievement, including sets of specific Achievement Indicators for each Prescribed Learning Outcome. Achievement indicators are statements that describe what students should be able to do in order to demonstrate that they fully meet the expectations set out by the Prescribed Learning Outcomes. Achievement indicators are not mandatory; they are provided to assist teachers in assessing how well their students achieve the Prescribed Learning Outcomes.

Also included in this section are key elements—descriptions of content that help determine the intended depth and breadth of Prescribed Learning Outcomes.

CLASSROOM ASSESSMENT MODEL

This section contains a series of classroom units that address the learning outcomes. The units have been developed and piloted by BC teachers, and are provided to support classroom assessment. These units are suggestions only—teachers may use or modify the units to assist them as they plan for the implementation of this curriculum.

Each unit includes the Prescribed Learning Outcomes and suggested Achievement Indicators, a suggested timeframe, a sequence of suggested assessment activities, and sample assessment instruments.
LEARNING RESOURCES

This section contains general information on learning resources, providing a link to titles, descriptions, and ordering information for the recommended learning resources in the Science 8 to 10 Grade Collections.

GLOSSARY

The glossary defines selected terms used in this Integrated Resource Package.
INTRODUCTION
This Integrated Resource Package (IRP) sets out the provincially prescribed curriculum for Science 8 to 10. The development of this IRP has been guided by the principles of learning:

- Learning requires the active participation of the student.
- People learn in a variety of ways and at different rates.
- Learning is both an individual and a group process.

In addition to these three principles, this document recognizes that British Columbia’s schools include students of varied backgrounds, interests, abilities, and needs. Wherever appropriate for this curriculum, ways to meet these needs and to ensure equity and access for all learners have been integrated as much as possible into the learning outcomes, Achievement Indicators, and assessment activities.

Science 8 to 10, in draft form, was available for public review and response from June to December, 2005. Feedback from educators, students, parents, and other educational partners informed the development of this updated IRP.

**RATIONALE**

Science education in British Columbia is designed to provide opportunities for students to develop scientific knowledge, skills, and attitudes that will be relevant in their everyday lives and their future careers. In addition to introducing them to current concepts, findings, and processes in various scientific disciplines – biology, physics, chemistry, astronomy, and geology – it encourages them to

- develop a positive attitude toward science
- examine basic concepts, principles, laws, and theories through scientific inquiry
- demonstrate respect for precision
- develop awareness of assumptions in all forms of science-related communication
- separate fundamental concepts from the less important or irrelevant
- identify supporting or refuting information and bias

- recognize that scientific knowledge is continually developing
- use given criteria for evaluating evidence and sources of information
- actively gain knowledge, skills, and attitudes that provide the basis for sound and ethical problem solving and decision making
- assess the impact of science and technology on individuals, society, and the environment
- cultivate appreciation of the scientific endeavour and their potential to contribute to science

To prepare students for further education and for their adult lives, the Science 8 to 10 curriculum engages students in the investigation of scientific questions and the development of plausible solutions. Science education develops and builds on students’ sense of wonder about the world around them and encourages a feeling of responsibility to sustain it. Science education fosters students’ desire to meet a challenge, take risks, and learn from mistakes. It prompts a curiosity about the changing world and helps students understand that the skills and knowledge they are gaining will be refined and expanded to reflect advances in scientific knowledge and technology.

**REQUIREMENTS AND GRADUATION CREDITS**

Science 10 is designated as a provincially examinable, four-credit course, and must be reported as such to the Ministry of Education for transcript purposes. Letter grades and percentages must be reported for this course.

**GRADUATION PROGRAM EXAMINATION**

Although the instructional approach for Science 8 to 10 is intended to be experiential in nature, the Grade 10 course has a set Graduation Program examination, worth 20% of the final course mark. All students taking Science 10 are required to write the examination in order to receive credit for this course.
INTRODUCTION TO SCIENCE 8 TO 10

For more information, refer to the Ministry of Education examinations web site: www.bced.gov.bc.ca/exams/

GOALS FOR SCIENCE 8 TO 10

The over-riding goals for Science 8 to 10 are represented in the Prescribed Learning Outcomes for Science 8 to 10 in each curriculum organizer. These goals are in alignment with the foundational statements from the Pan-Canadian Science Framework (Council of Ministers of Education, Canada,1997) that delineate the four critical aspects of students’ scientific literacy.

- **GOAL 1: Science, technology, society and the environment (STSE)** – 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.
- **GOAL 2: 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.
- **GOAL 3: 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.
- **GOAL 4: 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.

THE 2006 SCIENCE 8 TO 10 REVISION

This 2006 revision incorporates components from the 1996 provincial Science 8 to 10 curriculum and contributions of groups of British Columbia educators. At the same time, the allocation of topics at each grade reflects a commitment by the Ministry of Education to align, where possible and appropriate, the scope and sequence of science education in British Columbia with the scope and sequence outlined in the *K to 12 Common Framework of Learning Outcomes* (developed and published by the Council of Ministers of Education, Canada, under the aegis of the Pan-Canadian Protocol for Collaboration on School Curriculum). Among other benefits, it is anticipated that this alignment will facilitate inter-provincial transfers for students leaving or arriving in British Columbia and give British Columbia educators access to a wider range of choice when acquiring textbooks and other learning resources to teach Science 8 to 10.

A variety of resources were used in the development of this IRP:

- British Columbia *Science 8 to 10 IRP* (1996)
- Provincial science curricula
  - APEF (Atlantic Provinces Education Foundation)
  - Ontario
  - Manitoba
  - Alberta
- *Shared Learnings* (1998), Aboriginal Education Initiative, British Columbia Ministry of Education
CURRICULUM ORGANIZERS

A curriculum organizer consists of a set of Prescribed Learning Outcomes that share a common focus. The Prescribed Learning Outcomes for Science 8 to 10 are grouped under the following curriculum organizers:

• Processes of Science
• Life Sciences
• Physical Sciences
• Earth and Space Science

Note that these four organizers are for the purposes of identifying Prescribed Learning Outcomes; they are not intended to suggest a linear delivery of course material.

Processes of Science

Students in Science 8 to 10 are building on skills and processes that they have been developing from Kindergarten through to Grade 7. These include skills such as observing, classifying, predicting, inferring, and hypothesizing. Scientific reasoning, critical thinking, and decision making are also part of that foundation.

Beginning in Grade 8, the curriculum places greater emphasis on skills related to lab safety, scientific communication (e.g., representing information in graphic form), scientific literacy (e.g., being able to comprehend and evaluate science-related material), and understanding and using scientific technology (e.g., microscopes, equipment involved in the study of electricity). These emphases are maintained and reinforced at all three grade level, 8 to 10.

Although some discrete instruction related to Processes of Science will likely occur, it is anticipated that skills and processes of science will mostly be developed as part of work related to the other curriculum organizers (e.g., understanding how microscopes work and learning how to use them will occur in relation to the study of optics and the study of life science topics such as cells and micro-organisms). The curriculum accordingly assumes that instruction and assessment related to these skills and processes will be integrated and will occur frequently as appropriate throughout each year.

Life Science

At the 8 to 10 level, the Life Science organizer embraces a range of biology topics, moving from the microscopic level (the study of cellular processes and how these relate to tissues, organ systems in organisms, and reproduction) to the macroscopic level (the study of ecological complexity and the diversity, continuity, interactions, and balance among organisms and their environments).

Physical Science

At the 8 to 10 level, the Physical Science organizer incorporates a series of topics that give students a foundation for understanding Physics (via a focus on optics, fluids, electricity, and motion) and Chemistry (via a focus on atoms, elements, and chemical reactions). Two main Physical Science topics are dealt with in each year of the 8-10 program.

Earth and Space Science

As a complement to the study of topics in other areas of science (especially Physical Science), the Earth and Space Science organizer gives students an opportunity to examine some of the macroscopic applications of scientific principles and technologies in the study of terrestrial and extra-terrestrial systems.

ABORIGINAL CONTENT IN THE SCIENCE CURRICULUM

The science curriculum guide integrates Prescribed Learning Outcomes within a classroom model that includes instructional strategies, assessment tools and models that can help teachers provide all students with an understanding and appreciation of Aboriginal science. Integration of authentic Aboriginal content into the K to 10 science curriculum with the support of Aboriginal people will help promote understanding of BC’s Aboriginal peoples among all students.
The incorporating of Aboriginal science with western science can provide a meaningful context for Aboriginal students and enhance the learning experience for all students. The inclusion of Aboriginal examples of science and technologies can make the subject more authentic, exciting, relevant and interesting for all students.

Traditional Ecological Knowledge and Wisdom (TEKW) is defined as the study of systems of knowledge developed by a given culture. It brings the concept of wisdom to our discussion of science and technology. TEKW tends to be holistic, viewing the world as an interconnected whole where humans are not regarded as more important than nature. It is a subset of traditional science, and is considered a branch of biological and ecological science. This knowledge with its characteristic respect for sustaining community and environment offers proven conceptual approaches which are becoming increasingly important to all BC residents.

Examples of TEKW science may be accessed through living elders and specialists of various kinds or found in the literature of TEKW, anthropology, ethnology, ecology, biology, botany, ethnobiology, medicine, horticulture, agriculture, astronomy, geology, climatology, architecture, navigation, nautical science, engineering, and mathematics.

Recognition of the importance of incorporating TEKW into environmental planning is evident in science-based reports and agreements in Canada and internationally. The Brundtland Commission report, Our Common Future (World Commission on Environment and Development, 1987), drew our attention to the contributions of traditional knowledge. In British Columbia, the report of the scientific panel for sustainable forest practices in Clayoquot Sound emphasizes TEKW and the importance of including indigenous knowledge in planning and managing traditional territories. The recognition of TEKW globally is explicitly addressed in international agreements including the Convention on Biological Diversity, Agenda 21, and UNCED ‘92, or the Earth Summit at Rio de Janeiro.

**Suggested Time Frame**

Provincial curricula are developed in accordance with the amount of instructional time allocated for each subject area, while still allowing for flexibility to address local needs. For Science 8 to 10, around 12.5% of instructional hours per school year is recommended.

The following chart shows the suggested estimated instructional time to deliver the Prescribed Learning Outcomes for each Science curriculum organizer. These estimates have been provided as suggestions only; when delivering the prescribed curriculum, teachers will adjust the instructional time as necessary.

**Grade 8**

<table>
<thead>
<tr>
<th>Curriculum Organizer</th>
<th>Suggested Time Allocation</th>
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<tbody>
<tr>
<td>PROCESSES OF SCIENCE</td>
<td>integrated with other organizers</td>
</tr>
<tr>
<td>LIFE SCIENCE</td>
<td>20-25 hours</td>
</tr>
<tr>
<td>PHYSICAL SCIENCE</td>
<td>40-48 hours</td>
</tr>
<tr>
<td>EARTH AND SPACE SCIENCE</td>
<td>20-22 hours</td>
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</tbody>
</table>

**Grade 9**

<table>
<thead>
<tr>
<th>Curriculum Organizer</th>
<th>Suggested Time Allocation</th>
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<tbody>
<tr>
<td>PROCESSES OF SCIENCE</td>
<td>integrated with other organizers</td>
</tr>
<tr>
<td>LIFE SCIENCE</td>
<td>20-25 hours</td>
</tr>
<tr>
<td>PHYSICAL SCIENCE</td>
<td>40-45 hours</td>
</tr>
<tr>
<td>EARTH AND SPACE SCIENCE</td>
<td>20-25 hours</td>
</tr>
</tbody>
</table>

**Grade 10**

<table>
<thead>
<tr>
<th>Curriculum Organizer</th>
<th>Suggested Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROCESSES OF SCIENCE</td>
<td>integrated with other organizers</td>
</tr>
<tr>
<td>LIFE SCIENCE</td>
<td>20-25 hours</td>
</tr>
<tr>
<td>PHYSICAL SCIENCE</td>
<td>40-45 hours</td>
</tr>
<tr>
<td>EARTH AND SPACE SCIENCE</td>
<td>20-25 hours</td>
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## SCIENCE K-10: AT A GLANCE

<table>
<thead>
<tr>
<th>Grade</th>
<th>Processes and Skills of Science</th>
<th>Life Science</th>
<th>Physical Science</th>
<th>Earth and Space Science</th>
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</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>• observing • communicating (sharing)</td>
<td>Characteristics of Living Things</td>
<td>Properties of Objects and Materials</td>
<td>Surroundings</td>
</tr>
<tr>
<td>Grade 1</td>
<td>• communicating (recording) • classifying</td>
<td>Needs of Living Things</td>
<td>Force and Motion</td>
<td>Daily and Seasonal Changes</td>
</tr>
<tr>
<td>Grade 2</td>
<td>• interpreting observations • making inferences</td>
<td>Animal Growth and Changes</td>
<td>Properties of Matter</td>
<td>Air, Water, and Soil</td>
</tr>
<tr>
<td>Grade 3</td>
<td>• questioning • measuring and reporting</td>
<td>Plant Growth and Changes</td>
<td>Materials and Structures</td>
<td>Stars and Planets</td>
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<tr>
<td>Grade 4</td>
<td>• interpreting data • predicting</td>
<td>Habitats and Communities</td>
<td>Light and Sound</td>
<td>Weather</td>
</tr>
<tr>
<td>Grade 5</td>
<td>• designing experiments • fair testing</td>
<td>Human Body</td>
<td>Forces and Simple Machines</td>
<td>Renewable and Non-Renewable Resources</td>
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<tr>
<td>Grade 6</td>
<td>• controlling variables • scientific problem solving</td>
<td>Diversity of Life</td>
<td>Electricity</td>
<td>Exploration of Extreme Environments</td>
</tr>
<tr>
<td>Grade 7</td>
<td>• hypothesizing • developing models</td>
<td>Ecosystems</td>
<td>Chemistry</td>
<td>Earth’s Crust</td>
</tr>
<tr>
<td>Grade 8</td>
<td>• safety • scientific method • representing and interpreting scientific information</td>
<td>Cells and Systems</td>
<td>Optics • Fluids and Dynamics</td>
<td>Water Systems on Earth</td>
</tr>
<tr>
<td>Grade 9</td>
<td>• scientific literacy • ethical behaviour and cooperative skills</td>
<td>Reproduction</td>
<td>Atoms, Elements, and Compounds</td>
<td>Space Exploration</td>
</tr>
<tr>
<td>Grade 10</td>
<td>• application of scientific principles • science-related technology</td>
<td>Sustainability of Ecosystems</td>
<td>Chemical Reactions and Radioactivity</td>
<td>Energy Transfer in Natural Systems</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Motion</td>
<td>Plate Tectonics</td>
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CONSIDERATIONS FOR PROGRAM DELIVERY
CONSIDERATIONS FOR PROGRAM DELIVERY

This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners. Included in this section is information about:

- Alternative Delivery policy
- addressing local contexts
- involving parents and guardians
- course requirements respecting beliefs
- safety considerations
- confidentiality
- inclusion, equity, and accessibility
- working with the school and community
- working with the Aboriginal community
- information and communications technology
- copyright

ALTERNATIVE DELIVERY POLICY

The Alternative Delivery policy does not apply to the Science 8 to 10 curriculum.

The Alternative Delivery policy outlines how students, and their parents or guardians, in consultation with their local school authority, may choose means other than instruction by a teacher within the regular classroom setting for addressing Prescribed Learning Outcomes contained in the Health curriculum organizer of the following curriculum documents:

- Health and Career Education K to 7, and Personal Planning K to 7 Personal Development curriculum organizer (until September 2008)
- Health and Career Education 8 and 9
- Planning 10

The policy recognizes the family as the primary educator in the development of children’s attitudes, standards, and values, but the policy still requires that all Prescribed Learning Outcomes be addressed and assessed in the agreed-upon alternative manner of delivery.

It is important to note the significance of the term “alternative delivery” as it relates to the Alternative Delivery policy. The policy does not permit schools to omit addressing or assessing any of the Prescribed Learning Outcomes within the health and career education curriculum. Neither does it allow students to be excused from meeting any learning outcomes related to health. It is expected that students who arrange for alternative delivery will address the health-related learning outcomes and will be able to demonstrate their understanding of these learning outcomes.

For more information about policy relating to alternative delivery, refer to www.bc.ed.gov.bc.ca/policy/

ADDRESSING LOCAL CONTEXTS

There is some flexibility in the Science 8 to 10 curriculum, providing opportunities for individual teacher and student choice in the selection of topics to meet learning outcomes. This flexibility enables educators to plan their programs by using topics and examples that are relevant to their local context and to the particular interests of their students. When selecting topics it may be appropriate to incorporate student input.

INVOLVING PARENTS AND GUARDIANS

The family is the primary educator in the development of students’ attitudes and values. The school plays a supportive role by focussing on the Prescribed Learning Outcomes in the Science 8 to 10 curriculum. Parents and guardians can support, enrich, and extend the curriculum at home.

It is highly recommended that schools inform parents and guardians about the Science 8 to 10 curriculum, and teachers (along with school and district administrators) may choose to do so by:

- informing parents/guardians and students of the Prescribed Learning Outcomes for the subject by sending home class letters, providing an overview during parent-teacher interviews, etc.
- responding to parent and guardian requests to discuss course unit plans, learning resources, etc.
CONSIDERATIONS FOR PROGRAM DELIVERY

COURSE REQUIREMENTS RESPECTING BELIEFS

For many students and teachers, the study of some science concepts may lead to issues and questions that go beyond the immediate scope of curriculum (e.g., science is used to meet many industrial requirements, but industrial decision makers must consider factors other than scientific feasibility before adopting a particular process). The technological application of science in areas such as genetic engineering, human reproduction, and medical technology raises questions of ethics and values. Because these social questions arise, in part, from capabilities that science makes possible, they should be addressed. It must be made clear to students, however, that science only provides the background for what is hoped will be informed personal and social decisions. Teachers must handle these questions objectively and with sensitivity.

Reconciling scientific discoveries (for example, in age dating) and religious faith poses a particular challenge for some students. While respecting the personal beliefs of students, teachers should be careful to distinguish between knowledge based on the application of scientific methods, and religious teachings and associated beliefs such as creationism, theory of divine creation, or intelligent design theory.

SAFETY CONSIDERATIONS

Science education is an activity-based process that provides an exciting method of teaching and learning. However, experiments and demonstrations may involve inherent risks for both the teacher and the student.

Safety guidelines must be discussed with students. These safety guidelines must support and encourage the investigative approach generally and laboratory instruction specifically, while at the same time promoting safety in the classroom and laboratory. Encouraging a positive safety attitude is a responsibility shared among the board, school administrators, teachers, and students in every school district. The co-operation of all these groups helps develop a strong safety consciousness both inside and outside our schools.

Field work and field trips require special vigilance with respect to traffic and road safety, safe practices in study areas and when obtaining samples, and an awareness of changes in weather.

Another important aspect of in-school safety is the Workplace Hazardous Materials Information Systems (WHMIS). Through labelling, material safety data sheets, and education and training, WHMIS is designed to ensure that those using hazardous materials have sufficient information to handle them safely. Each school district should have an individual trained in WHMIS who can work with teachers to establish safe, well-ventilated classroom and laboratory working conditions.

To assist teachers in providing a safe science-learning environment, the Ministry of Education publishes the Science Safety Resource Manual, which has been distributed to every school.

The Science Safety Resource Manual is available online at
www.bced.gov.bc.ca/irp/resdocs/scisafety.htm

CONFIDENTIALITY

The Freedom of Information and Protection of Privacy Act (FOIPPA) applies to students, to school district employees, and to all curricula. Teachers, administrators, and district staff should consider the following:

- Be aware of district and school guidelines regarding the provisions of FOIPPA and how it applies to all subjects, including Science 8 to 10.
- Do not use students’ Personal Education Numbers (PEN) on any assignments that students wish to keep confidential.
- Ensure students are aware that if they disclose personal information that indicates they are at risk for harm, then that information cannot be kept confidential.
- Inform students of their rights under FOIPPA, especially the right to have access to their own
personal information in their school records. Inform parents of their rights to access their children’s school records.

- Minimize the type and amount of personal information collected, and ensure that it is used only for purposes that relate directly to the reason for which it is collected.
- Inform students that they will be the only ones recording personal information about themselves unless they, or their parents, have consented to teachers collecting that information from other people (including parents).
- Provide students and their parents with the reason(s) they are being asked to provide personal information in the context of the Science 8 to 10 curriculum.
- Inform students and their parents that they can ask the school to correct or annotate any of the personal information held by the school, in accordance with Section 29 of FOIPPA.
- Ensure students are aware that their parents may have access to the schoolwork they create only insofar as it pertains to students’ progress.
- Ensure that any information used in assessing students’ progress is up-to-date, accurate, and complete.

For more information about confidentiality, refer to www.mser.gov.bc.ca/FOI_POP/index.htm

INCLUSION, EQUITY, AND ACCESSIBILITY FOR ALL LEARNERS

British Columbia’s schools include students of varied backgrounds, interests, and abilities. The Kindergarten to grade 12 school system focusses on meeting the needs of all students. When selecting specific topics, activities, and resources to support the implementation of Science 8 to 10, teachers are encouraged to ensure that these choices support inclusion, equity, and accessibility for all students. In particular, teachers should ensure that classroom instruction, assessment, and resources reflect sensitivity to diversity and incorporate positive role portrayals, relevant issues, and themes such as inclusion, respect, and acceptance.

Government policy supports the principles of integration and inclusion of students who have English as a second language and of students with special needs. Most of the Prescribed Learning Outcomes and suggested Achievement Indicators in this IRP can be met by all students, including those with special needs and/or ESL needs. Some strategies may require adaptations to ensure that those with special and/or ESL needs can successfully achieve the learning outcomes. Where necessary, modifications can be made to the Prescribed Learning Outcomes for students with Individual Education Plans.

For more information about resources and support for students with special needs, refer to www.bced.gov.bc.ca/specialed/

For more information about resources and support for ESL students, refer to www.bced.gov.bc.ca/esl/

WORKING WITH THE SCHOOL AND COMMUNITY

This curriculum addresses a wide range of skills and understandings that students are developing in other areas of their lives. It is important to recognize that learning related to this curriculum extends beyond the science classroom.

School and district-wide programs support and extend learning in Science 8 to 10. Community organizations may also support the curriculum with locally developed learning resources, guest speakers, workshops, and field studies. Teachers may wish to draw on the expertise of these community organizations and members.
WORKING WITH THE ABORIGINAL COMMUNITY

The Ministry of Education is dedicated to ensuring that the cultures and contributions of Aboriginal peoples in BC are reflected in all provincial curricula. To address these topics in the classroom in a way that is accurate and that respectfully reflects Aboriginal concepts of teaching and learning, teachers are strongly encouraged to seek the advice and support of local Aboriginal communities. As Aboriginal communities are diverse in terms of language, culture, and available resources, each community will have its own unique protocol to gain support for integration of local knowledge and expertise. To begin discussion of possible instructional and assessment activities, teachers should first contact Aboriginal education co-ordinators, teachers, support workers, and counsellors in their district who will be able to facilitate the identification of local resources and contacts such as elders, chiefs, tribal or band councils, Aboriginal cultural centres, Aboriginal Friendship Centres, and Métis or Inuit organizations.

In addition, teachers may wish to consult the various Ministry of Education publications available, including the “Planning Your Program” section of the resource, Shared Learnings. This resource was developed to help all teachers provide students with knowledge of, and opportunities to share experiences with, Aboriginal peoples in BC.

For more information about these documents, consult the Aboriginal Education web site: www.bced.gov.bc.ca/abed/welcome.htm

INFORMATION AND COMMUNICATIONS TECHNOLOGY

The study of information and communications technology is increasingly important in our society. Students need to be able to acquire and analyse information, to reason and communicate, to make informed decisions, and to understand and use information and communications technology for a variety of purposes. Development of these skills is important for students in their education, their future careers, and their everyday lives.

Literacy in the area of information and communications technology can be defined as the ability to obtain and share knowledge through investigation, study, instruction, or transmission of information by means of media technology. Becoming literate in this area involves finding, gathering, assessing, and communicating information using electronic means, as well as developing the knowledge and skills to use and solve problems effectively with the technology. Literacy also involves a critical examination and understanding of the ethical and social issues related to the use of information and communications technology. When planning for instruction and assessment in Science 8 to 10, teachers should provide opportunities for students to develop literacy in relation to information and communications technology sources, and to reflect critically on the role of these technologies in society.

COPYRIGHT AND RESPONSIBILITY

Copyright is the legal protection of literary, dramatic, artistic, and musical works; sound recordings; performances; and communications signals. Copyright provides creators with the legal right to be paid for their work and the right to say how their work is to be used. There are some exceptions in the law (i.e., specific things permitted) for schools but these are very limited, such as copying for private study or research. The copyright law determines how resources can be used in the classroom and by students at home.

In order to respect copyright it is necessary to understand the law. It is unlawful to do the following, unless permission has been given by a copyright owner:

- photocopy copyrighted material to avoid purchasing the original resource for any reason
- photocopy or perform copyrighted material beyond a very small part—in some cases the
CONSIDERATIONS FOR PROGRAM DELIVERY

Many creators, publishers, and producers have formed groups or “collectives” to negotiate royalty payments and copying conditions for educational institutions. It is important to know what licences are in place and how these affect the activities schools are involved in. Some licences may also have royalty payments that are determined by the quantity of photocopying or the length of performances. In these cases, it is important to assess the educational value and merits of copying or performing certain works to protect the school’s financial exposure (i.e., only copy or use that portion that is absolutely necessary to meet an educational objective).

It is important for education professionals, parents, and students to respect the value of original thinking and the importance of not plagiarizing the work of others. The works of others should not be used without their permission.

Permission from or on behalf of the copyright owner must be given in writing. Permission may also be given to copy or use all or some portion of copyrighted work through a licence or agreement.

For more information about copyright, refer to www.cmec.ca/copyright/indexe.stm
PRESCRIBED LEARNING OUTCOMES
Prescribed learning outcomes are content standards for the provincial education system; they are the prescribed curriculum. Clearly stated and expressed in measurable and observable terms, learning outcomes set out the required attitudes, skills, and knowledge—what students are expected to know and be able to do—by the end of the subject and grade.

Schools have the responsibility to ensure that all Prescribed Learning Outcomes in this curriculum are met; however, schools have flexibility in determining how delivery of the curriculum can best take place.

It is expected that student achievement will vary in relation to the learning outcomes. Evaluation, reporting, and student placement with respect to these outcomes are dependent on the professional judgment and experience of teachers, guided by provincial policy.

Prescribed learning outcomes for Science 8 to 10 are presented by grade and by curriculum organizer and suborganizer, and are coded alphanumerically for ease of reference; however, this arrangement is not intended to imply a required instructional sequence.

Wording of Prescribed Learning Outcomes

All learning outcomes complete the stem, “It is expected that students will ....”

When used in a Prescribed Learning Outcome, the word “including” indicates that any ensuing item must be addressed. Lists of items introduced by the word “including” represent a set of minimum requirements associated with the general requirement set out by the outcome. The lists are not necessarily exhaustive, however, and teachers may choose to address additional items that also fall under the general requirement set out by the outcome.

Conversely, the abbreviation “e.g.,” (for example) in a Prescribed Learning Outcome indicates that the ensuing items are provided for illustrative purposes or clarification, and are not requirements that must be addressed. Presented in parentheses, the list of items introduced by “e.g.,” is neither exhaustive nor prescriptive, nor is it put forward in any special order of importance or priority. Teachers are free to substitute items of their own choosing that they feel best address the intent of the learning outcome.

Domains of Learning

Prescribed learning outcomes in BC curricula identify required learning in relation to one or more of the three domains of learning: cognitive, psychomotor, and affective. The following definitions of the three domains are based on Bloom’s taxonomy.

The cognitive domain deals with the recall or recognition of knowledge and the development of intellectual abilities. The cognitive domain can be further specified as including three cognitive levels: knowledge, understanding and application, and higher mental processes. These levels are determined by the verb used in the learning outcome, and illustrate how student learning develops over time.

- Knowledge includes those behaviours that emphasize the recognition or recall of ideas, material, or phenomena.
- Understanding and application represents a comprehension of the literal message contained in a communication, and the ability to apply an appropriate theory, principle, idea, or method to a new situation.
- Higher mental processes include analysis, synthesis, and evaluation. The higher mental processes level subsumes both the knowledge and the understanding and application levels.

The affective domain concerns attitudes, beliefs, and the spectrum of values and value systems.

The psychomotor domain includes those aspects of learning associated with movement and skill demonstration, and integrates the cognitive and
affective consequences with physical performances.

Domains of learning and cognitive levels also form the basis of the Assessment Overview Tables provided for each grade in the Classroom Assessment Model. In addition, domains of learning and, particularly, cognitive levels, inform the design and development of the Graduation Program examination for Science 10.
PREScribed Learning Outcomes

Grade 10
GRADE 10

**Processes of Science**

*It is expected that students will:*

A1 demonstrate safe procedures  
A2 perform experiments using the scientific method  
A3 represent and interpret information in graphic form  
A4 demonstrate scientific literacy  
A5 demonstrate ethical, responsible, cooperative behaviour  
A6 describe the relationship between scientific principles and technology  
A7 demonstrate competence in the use of technologies specific to investigative procedures and research

**Life Science: Sustainability of Ecosystems**

*It is expected that students will:*

B1 explain the interaction of abiotic and biotic factors within an ecosystem  
B2 assess the potential impacts of bioaccumulation  
B3 explain various ways in which natural populations are altered or kept in equilibrium

**Physical Science: Chemical Reactions and Radioactivity**

*It is expected that students will:*

C1 differentiate between atoms, ions, and molecules using knowledge of their structure and components  
C2 classify substances as acids, bases, or salts, based on their characteristics, name, and formula  
C3 distinguish between organic and inorganic compounds  
C4 analyse chemical reactions, including reference to conservation of mass and rate of reaction  
C5 explain radioactivity using modern atomic theory

**Physical Science: Motion**

C6 explain the relationship of displacement and time interval to velocity for objects in uniform motion  
C7 demonstrate the relationship between velocity, time interval, and acceleration

**Earth and Space Science: Energy Transfer in Natural Systems**

*It is expected that students will:*

D1 explain the characteristics and sources of thermal energy  
D2 explain the effects of thermal energy within the atmosphere  
D3 evaluate possible causes of climate change and its impact on natural systems

**Earth and Space Science: Plate Tectonics**

D4 analyse the processes and features associated with plate tectonics  
D5 demonstrate knowledge of evidence that supports plate tectonic theory
This section of the IRP contains information about classroom assessment and student achievement, including specific Achievement Indicators to assist teachers in assessing student achievement in relation to each Prescribed Learning Outcome. Also included in this section are key elements – descriptions of content that help determine the intended depth and breadth of Prescribed Learning Outcomes.

CLASSROOM ASSESSMENT AND EVALUATION

Assessment is the systematic gathering of information about what students know, are able to do, and are working toward. Assessment evidence can be collected using a wide variety of methods, such as

- observation
- student self-assessments and peer assessments
- quizzes and tests (written, oral, practical)
- samples of student work
- projects
- oral and written reports
- journals and learning logs
- performance reviews
- portfolio assessments

Student performance is based on the information collected through assessment activities. Teachers use their insight, knowledge about learning, and experience with students, along with the specific criteria they establish, to make judgments about student performance in relation to Prescribed Learning Outcomes.

There are three major types of assessment that can be used in conjunction with each other to support student achievement.

- Assessment for learning is assessment for purposes of greater learning achievement.
- Assessment as learning is assessment as a process of developing and supporting students’ active participation in their own learning.
- Assessment of learning is assessment for purposes of providing evidence of achievement for reporting.

Assessment for Learning

Classroom assessment for learning provides ways to engage and encourage students to become involved in their own day-to-day assessment—to acquire the skills of thoughtful self-assessment and to promote their own achievement.

This type of assessment serves to answer the following questions

- What do students need to learn to be successful?
- What does the evidence of this learning look like?

Assessment for learning is criterion-referenced, in which a student’s achievement is compared to established criteria rather than to the performance of other students. Criteria are based on Prescribed Learning Outcomes, as well as on suggested Achievement Indicators or other learning expectations.

Students benefit most when assessment feedback is provided on a regular, ongoing basis. When assessment is seen as an opportunity to promote learning rather than as a final judgment, it shows students their strengths and suggests how they can develop further. Students can use this information to redirect their efforts, make plans, communicate with others (e.g., peers, teachers, parents) about their growth, and set future learning goals.

Assessment for learning also provides an opportunity for teachers to review what their students are learning and what areas need further attention. This information can be used to inform teaching and create a direct link between assessment and instruction. Using assessment as a way of obtaining feedback on instruction supports student achievement by informing teacher planning and classroom practice.

Assessment as Learning

Assessment as learning actively involves students in their own learning processes. With support and guidance from their teacher, students take responsibility for their own learning, constructing
**Student Achievement**

meaning for themselves. Through a process of continuous self-assessment, students develop the ability to take stock of what they have already learned, determine what they have not yet learned, and decide how they can best improve their own achievement.

Although assessment as learning is student-driven, teachers can play a key role in facilitating how this assessment takes place. By providing regular opportunities for reflection and self-assessment, teachers can help students develop, practise, and become comfortable with critical analysis of their own learning.

**Assessment of Learning**

Assessment of learning can be addressed through summative assessment, including large-scale assessments and teacher assessments. These summative assessments can occur at the end of the year or at periodic stages in the instructional process.

Large-scale assessments, such as Foundation Skills Assessment (FSA) and Graduation Program exams, gather information on student performance throughout the province and provide information for the development and revision of curriculum. These assessments are used to make judgments about students’ achievement in relation to provincial and national standards. The large-scale provincial assessment for Science 8 to 10 is the graduation program examination for Science 10, worth 20% of the final course mark. This exam is a requirement for all students taking Science 10.

Assessment of learning is also used to inform formal reporting of student achievement.

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For Ministry of Education reporting policy, refer to [www.bced.gov.bc.ca/policy/policies/student_reporting.htm](http://www.bced.gov.bc.ca/policy/policies/student_reporting.htm)

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<table>
<thead>
<tr>
<th>Assessment for Learning</th>
<th>Assessment as Learning</th>
<th>Assessment of Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formative assessment ongoing in the classroom</strong></td>
<td><strong>Formative assessment ongoing in the classroom</strong></td>
<td><strong>Summative assessment occurs at end of year or at key stages</strong></td>
</tr>
<tr>
<td>• teacher assessment, student self-assessment, and/or student peer assessment</td>
<td>• self-assessment</td>
<td>• teacher assessment</td>
</tr>
<tr>
<td>• criterion-referenced—criteria based on Prescribed Learning Outcomes identified in the provincial curriculum, reflecting performance in relation to a specific learning task</td>
<td>• provides students with information on their own achievement and prompts them to consider how they can continue to improve their learning</td>
<td>• may be either criterion-referenced (based on Prescribed Learning Outcomes) or norm-referenced (comparing student achievement to that of others)</td>
</tr>
<tr>
<td>• involves both teacher and student in a process of continual reflection and review about progress</td>
<td>• student-determined criteria based on previous learning and personal learning goals</td>
<td>• information on student performance can be shared with parents/guardians, school and district staff, and other education professionals (e.g., for the purposes of curriculum development)</td>
</tr>
<tr>
<td>• teachers adjust their plans and engage in corrective teaching in response to formative assessment</td>
<td>• students use assessment information to make adaptations to their learning process and to develop new understandings</td>
<td>• used to make judgments about students’ achievement in relation to provincial standards</td>
</tr>
</tbody>
</table>
For more information about assessment for, as, and of learning, refer to the following resource developed by the Western and Northern Canadian Protocol (WNCP): *Rethinking Assessment with Purpose in Mind*.

![This resource is available online at](www.wncp.ca)

**Criterion-Referenced Assessment and Evaluation**

In criterion-referenced evaluation, a student’s performance is compared to established criteria rather than to the performance of other students. Evaluation in relation to prescribed curriculum requires that criteria be established based on the learning outcomes.

**Criterion-referenced assessment and evaluation may involve these steps:**

**Step 1** Identify the Prescribed Learning Outcomes and suggested Achievement Indicators (as articulated in this IRP) that will be used as the basis for assessment.

**Step 2** Establish criteria. When appropriate, involve students in establishing criteria.

**Step 3** Plan learning activities that will help students gain the attitudes, skills, or knowledge outlined in the criteria.

**Step 4** Prior to the learning activity, inform students of the criteria against which their work will be evaluated.

**Step 5** Provide examples of the desired levels of performance.

**Step 6** Conduct the learning activities.

**Step 7** Use appropriate assessment instruments (e.g., rating scale, checklist, scoring guide) and methods (e.g., observation, collection, self-assessment) based on the particular assignment and student.

**Step 8** Review the assessment data and evaluate each student’s level of performance or quality of work in relation to criteria.

**Step 9** Where appropriate, provide feedback and/or a letter grade to indicate how well the criteria are met.

**Step 10** Communicate the results of the assessment and evaluation to students and parents/guardians.

Criteria are the basis for evaluating student progress. They identify, in specific terms, the critical aspects of a performance or a product that indicate how well the student is meeting the Prescribed Learning Outcomes. For example, weighted criteria, rating scales, or scoring guides (reference sets) are ways that student performance can be evaluated using criteria.

Wherever possible, students should be involved in setting the assessment criteria. This helps students develop an understanding of what high-quality work or performance looks like.
**KEY ELEMENTS**

Key elements provide an overview of content in each curriculum organizer and suborganizer. They can be used to determine the expected depth and breadth of the Prescribed Learning Outcomes.

Note that some topics appear at multiple grade levels in order to emphasize their importance and to allow for developmental learning.

**ACHIEVEMENT INDICATORS**

To support teachers in assessing provincially prescribed curricula, this IRP includes sets of Achievement Indicators in relation to each learning outcome.

Achievement indicators, taken together as a set, define the specific level of attitudes demonstrated, skills applied, or knowledge acquired by the student in relation to a corresponding Prescribed Learning Outcome. They describe what evidence a teacher might look for to determine whether or not the student has fully met the intent of the learning outcome. Since each Achievement Indicator defines only one aspect of what is covered by the corresponding learning outcome, teachers should consider students’ abilities to accomplish all of the aspects set out by the entire set of Achievement Indicators in determining whether or not students have fully met the learning outcome.

In some cases, Achievement Indicators may also include suggestions as to the type of task that would provide evidence of having met the learning outcome (e.g., a constructed response such as a list, comparison, analysis, or chart; a product created and presented such as a report, drama presentation, poster, letter, or model; a particular skill demonstrated such as interpreting graphs).

Achievement indicators support assessment for learning, assessment as learning, and assessment of learning. They provide teachers and parents with tools that can be used to reflect on what students are learning. They also provide students with a means of self-assessment and ways of defining how they can improve their own achievement.

Achievement indicators are not mandatory; they are suggestions only, provided to assist teachers in assessing how well their students achieve the Prescribed Learning Outcomes. Achievement indicators may be useful to provincial examination development teams and inform the development of exam items. However, examination questions, item formats, exemplars, rubrics, or scoring guides will not necessarily be limited to the Achievement Indicators as outlined in the Integrated Resource Packages.

**Specifications for provincial examinations are available online at**

[www.bced.gov.bc.ca/exams/specs/](http://www.bced.gov.bc.ca/exams/specs/)

The following pages contain the suggested Achievement Indicators corresponding to each Prescribed Learning Outcome for the Science 8 to 10 curriculum. The Achievement Indicators are arranged by curriculum organizer and suborganizer for each grade; however, this order is not intended to imply a required sequence of instruction and assessment.
STUDENT ACHIEVEMENT

Grade 10
GRADE 10

KEY ELEMENTS: PROCESSES OF SCIENCE

Estimated Time: integrate with other curriculum organizers

The Prescribed Learning Outcomes related to Processes of Science support the development of attitudes, skills, and knowledge essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other three curriculum organizers.

Vocabulary
accuracy, conclusion, control, controlled experiment, dependent variables, hypothesis, independent variables, observation, precision, prediction, procedure, principle, scientific literacy, uncertainty, validity, variable

Knowledge
• metric system (SI units)
• elements of a valid experiment
• dependent and independent variables
• appropriate scale
• application of scientific principles in the development of technologies

Skills and Attitudes
• recognize dangers
• demonstrate emergency response procedures
• use personal protective equipment
• use proper techniques for handling and disposing of lab materials
• use the Bunsen burner and hotplate
• make accurate measurements using a variety of instruments (e.g., rulers, balances, graduated cylinders)
• use the Internet as a research tool
• communicate results
• use appropriate types of graphic models and/or formulae to represent a given type of data, including the Bohr model
• use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
• deduce relationships between variables given a graph or by constructing graphs
• use models to demonstrate how systems operate
• apply given criteria for evaluating evidence and sources of information
• identify main points, supporting or refuting information, and bias in a science-related article or illustration
• demonstrate ethical, responsible, cooperative behaviour
• acquire and apply scientific and technological knowledge to the benefit of self, society, and the environment
## Grade 10 Processes of Science

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome. Students who have fully met the Prescribed Learning Outcome are able to:</td>
</tr>
</tbody>
</table>

### A1  demonstrate safe procedures
- identify a variety of dangers in procedures (e.g., cuts from sharp objects; explosions or burns from handling chemicals or heating materials)
- identify appropriate equipment for an lab activity (e.g., Bunsen burner vs. hotplate; glassware for chemicals)
- identify and use appropriate personal protective equipment (e.g., hand and eye protection) and procedures (e.g., hair tied back, clear work area, no loose clothing, no horseplay)
- use proper techniques for handling and disposing of lab materials (e.g., using special containers for caustic chemicals)
- describe appropriate emergency response procedures (e.g., how to use a fire extinguisher/blanket, eye wash station, first aid for cuts and burns, knowing who to contact and how)

### A2  perform experiments using the scientific method
- describe the elements of a valid experiment:
  - formulate an hypothesis
  - make a prediction
  - identify controlled versus experimental variables
  - observe, measure, and record using appropriate units
  - interpret data
  - draw conclusions
- use information and conclusions as a basis for further comparisons, investigations, or analyses
- communicate results using a variety of methods

### A3  represent and interpret information in graphic form
- identify and use the most appropriate type of graphic, model, or formula to convey information, including
  - Bohr model or diagram
  - convection model or diagram
  - Lewis diagrams
  - chemical formulae
  - line graphs of displacement, time interval, and velocity
  - diagrams (e.g., food webs/pyramids, nutrient cycles, plate boundaries)
- distinguish between dependent and independent variables in a graph
- use appropriate scale and axis to create a graph
- extrapolate and interpolate points on a graph
- extract information from maps, bar graphs, line graphs, tables, and diagrams (e.g., periodic table)
<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
</table>
| A4  demonstrate scientific literacy | - identify the main points in a science-related article or illustration  
- describe the qualities of the scientifically literate person, such as  
  - awareness of assumptions (their own and authors’)  
  - respect for precision  
  - ability to separate fundamental concepts from the irrelevant or unimportant  
  - recognizing that scientific knowledge is continually developing and often builds upon previous theories  
  - recognizing cause and effect  
- use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)  
- explain how science and technology affect individuals, society, and the environment |
| A5  demonstrate ethical, responsible, cooperative behaviour | - describe and demonstrate  
  - ethical behaviour (e.g., honesty, fairness, reliability)  
  - open-mindedness (e.g., ongoing examination and reassessment of own beliefs)  
  - willingness to question and promote discussion  
  - skills of collaboration and co-operation  
  - respect for the contributions of others |
| A6  describe the relationship between scientific principles and technology | - give examples of scientific principles that have resulted in the development of technologies (e.g., velocity/acceleration—technologies related to transportation and athletics)  
- identify a variety of technologies and explain how they have advanced our understanding of science (e.g., seismographic instruments and GPS—plate tectonics and Earth’s layers) |
| A7  demonstrate competence in the use of technologies specific to investigative procedures and research | - select and carefully use balances and other measurement tools (e.g., thermometers, timing devices, electronic devices)  
- proficiently use the Internet as a research tool |
GRADE 10

KEY ELEMENTS: LIFE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have assessed the significance of natural phenomena and human factors within ecosystems.

Vocabulary
abiotic, aeration, adaptive radiation, bioaccumulation, biodegradation, biome, biotic, climax community, carbonate, commensalism, decomposers, denitrification, ecological succession, ecosystem, food chains, food pyramids, food webs, heavy metals, keystone species, lightning, mutualism, nitrification, natural selection, nutrients, parasitism, PCBs, pesticides, pH, phosphorus, photosynthesis, potassium, predation, proliferation, symbiosis, trophic levels

Knowledge
• abiotic and biotic elements in ecosystems
• cycling of carbon, nitrogen, oxygen, and phosphorus
• ecosystems with similar characteristics in different geographical locations
• effects of altering an abiotic factor
• species adaptation
• food webs and pyramids
• mechanisms and possible impacts of bioaccumulation
• traditional ecological knowledge (TEK)
• impact of natural phenomena, foreign species, disease, pollution, habitat destruction, and exploitation of resources on ecosystems

Skills and Attitudes
• use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
• formulate a reasoned position
• demonstrate ethical behaviour
• relate cause to effect
• assess human impact
• show respect and sensitivity for the environment
• conduct experiments
# Grade 10 Life Science: Sustainability of Ecosystems

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
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</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.</td>
</tr>
<tr>
<td>Students who have fully met the Prescribed Learning Outcome are able to:</td>
<td></td>
</tr>
<tr>
<td>B1 explain the interaction of abiotic and biotic factors within an ecosystem</td>
<td>define <strong>abiotic</strong>, <strong>biotic</strong>, <strong>biome</strong>, and <strong>ecosystem</strong></td>
</tr>
<tr>
<td></td>
<td>identify distinctive plants, animals, and climatic characteristics of Canadian biomes (tundra, boreal forest, temperate deciduous forest, temperate rainforest, grasslands)</td>
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<tr>
<td></td>
<td>identify biotic and abiotic factors in a given scenario or diagram</td>
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<tr>
<td></td>
<td>describe the relationships between abiotic and biotic elements within an ecosystem, including</td>
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<tr>
<td></td>
<td>- air, water, soil, light, temperature (abiotic)</td>
</tr>
<tr>
<td></td>
<td>- bacteria, plants, animals (biotic)</td>
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<tr>
<td></td>
<td>design and analyse experiments on the effects of altering biotic or abiotic factors (e.g., nutrients in soil: compare two plant types with the same nutrients, compare one plant type with different nutrients)</td>
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<tr>
<td></td>
<td>explain various relationships with respect to food chains, food webs, and food pyramids, including</td>
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<tr>
<td></td>
<td>- producer</td>
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<tr>
<td></td>
<td>- consumer (herbivore, carnivore, omnivore)</td>
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<td></td>
<td>- predation (predator-prey cycle)</td>
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<tr>
<td></td>
<td>- decomposers</td>
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<td></td>
<td>- symbiosis (mutualism, commensalism, parasitism)</td>
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<td></td>
<td>illustrate the cycling of matter through abiotic and biotic components of an ecosystem by tracking</td>
</tr>
<tr>
<td></td>
<td>- carbon (with reference to carbon dioxide – CO$_2$, carbonate CO$_3^{2-}$, oxygen – O$_2$, photosynthesis, respiration, decomposition, volcanic activity, carbonate formation, greenhouse gases from human activity, combustion)</td>
</tr>
<tr>
<td></td>
<td>- nitrogen (with reference to nitrate – NO$_3^-$, nitrite – NO$_2^-$, ammonium – NH$_4^+$, nitrogen gas – N$_2$, nitrogen fixation, bacteria, lightning, nitrification, denitrification, decomposition)</td>
</tr>
<tr>
<td></td>
<td>- phosphorus (with reference to phosphate – PO$_4^{3-}$, weathering, sedimentation, geological uplift)</td>
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<td></td>
<td>identify factors that affect the global distribution of the following biomes: tropical rainforest, temperate rainforest, temperate deciduous forest, boreal forest, grasslands, desert, tundra, polar ice</td>
</tr>
<tr>
<td>Prescribed Learning Outcomes</td>
<td>Suggested Achievement Indicators</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>B2</td>
<td>assess the potential impacts of bioaccumulation</td>
</tr>
<tr>
<td></td>
<td>□ using examples, explain why ecosystems with similar characteristics can exist in different geographical locations (i.e., significance of abiotic factors)</td>
</tr>
<tr>
<td></td>
<td>□ identify the effects on living things within an ecosystem resulting from changes in abiotic factors, including</td>
</tr>
<tr>
<td></td>
<td>- climate change (drought, flooding, changes in ocean current patterns, extreme weather)</td>
</tr>
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<td></td>
<td>- water contamination</td>
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<tr>
<td></td>
<td>- soil degradation and deforestation</td>
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<tr>
<td></td>
<td>□ define, using examples, the terms bioaccumulation, parts per million (ppm), biodegradation, and trophic levels (with reference to producers and to primary, secondary, and tertiary consumers)</td>
</tr>
<tr>
<td></td>
<td>□ identify a variety of contaminants that can bioaccumulate (e.g., pesticides, heavy metals, PCBs)</td>
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<tr>
<td></td>
<td>□ describe the mechanisms and possible impacts of bioaccumulation (e.g., eradication of keystone species, reproductive impacts)</td>
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<tr>
<td></td>
<td>□ compare the impact of bioaccumulation on consumers at different trophic levels (e.g., red tide in oysters and humans; heavy metals in fish and humans; PCBs in fish, birds, whales)</td>
</tr>
<tr>
<td></td>
<td>□ research and analyse articles on the causes and effects of bioaccumulation (e.g., mercury contamination in Inuit communities and the Grassy Narrows First Nation community)</td>
</tr>
<tr>
<td>B3</td>
<td>explain various ways in which natural populations are altered or kept in equilibrium</td>
</tr>
<tr>
<td></td>
<td>□ explain how species adapt or fail to adapt to environmental conditions, with reference to the following:</td>
</tr>
<tr>
<td></td>
<td>- natural selection</td>
</tr>
<tr>
<td></td>
<td>- proliferation</td>
</tr>
<tr>
<td></td>
<td>- predator/prey cycle</td>
</tr>
<tr>
<td></td>
<td>- ecological succession</td>
</tr>
<tr>
<td></td>
<td>- climax community</td>
</tr>
<tr>
<td></td>
<td>- extinction</td>
</tr>
<tr>
<td></td>
<td>- adaptive radiation</td>
</tr>
<tr>
<td></td>
<td>□ describe the impact of natural phenomena (e.g., drought, fire, temperature change, flooding, tsunamis, infestations—pine beetle, volcanic eruptions) on ecosystems</td>
</tr>
<tr>
<td></td>
<td>□ give examples of how foreign species can affect an ecosystem (e.g., Eurasian milfoil, purple loosestrife, scotch broom, American bullfrog, European starling in BC)</td>
</tr>
<tr>
<td></td>
<td>□ give examples of how traditional ecological knowledge (TEK) can affect biodiversity (e.g., spring burning by Cree in northern Alberta)</td>
</tr>
<tr>
<td></td>
<td>□ research and report on situations in which disease, pollution, habitat destruction, and exploitation of resources affect ecosystems</td>
</tr>
</tbody>
</table>
# Grade 10

## Key Elements: Physical Science

**Estimated Time: 40-45 hours**

By the end of the grade, students will have demonstrated understanding of chemical reactions and radioactivity, and explained motion in terms of displacement, time interval, velocity, and acceleration.

*Chemical Reactions and Radioactivity (30 hours)*

**Vocabulary**

acids, alpha particle, atomic number, atoms, bases, beta particle, Bohr diagrams, bromothymol blue, catalyst, combustion, compounds, concentration, conservation of mass, covalent bonding, decomposition, electron, fission, fusion, gamma radiation, half-life, indigo carmine, inorganic, ionic bonding, ions, isotope, Lewis diagrams, light, litmus paper, mass number, methyl orange, molecules, neutralization (acid-base), neutron, organic, phenolphthalein, polyatomic, proton, radioactive decay, salts, single and double replacement, surface area, symbolic equations, synthesis, valence electron

**Knowledge**

- acids, bases, and salts
- common ionic and covalent compounds
- organic and inorganic compounds
- chemical reactions (synthesis, decomposition, single and double replacement, neutralization, combustion)
- conservation of mass
- radioactivity

**Skills and Attitudes**

- draw and interpret Bohr models
- draw and interpret Lewis diagrams for compounds containing single bonds
- name and write chemical formulae for common ionic and covalent compounds, using appropriate terminology
- use standardized tests for acids and bases
- write and balance chemical equations
- write and balance nuclear equations
- use molecular models
- use the periodic table and ion charts
- demonstrate respect for precision
**Key Elements: Physical Science**

*Motion* (10-15 hours)

**Vocabulary**
acceleration, displacement, slope, time interval, uniform motion, velocity

**Knowledge**
- relationship of displacement and time interval to velocity
- motion of objects
- uniform motion
- acceleration due to gravity
- acceleration: positive, negative, and zero

**Skills and Attitudes**
- calculate using \( v_{av} = \frac{\Delta x}{\Delta t} \)
- calculate using \( a = \frac{\Delta v}{\Delta t} \), where \( \Delta v = v_f - v_i \)
- demonstrate respect for precision
## Grade 10 Physical Science: Chemical Reactions and Radioactivity

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.</td>
</tr>
</tbody>
</table>

Students who have fully met the Prescribed Learning Outcome are able to:

**C1** Differentiate between atoms, ions, and molecules using knowledge of their structure and components

- Demonstrate knowledge of the three subatomic particles, their properties, and their location within the atom (e.g., by creating models)
- Define and give examples of ionic bonding (e.g., metal and non-metal) and covalent bonding (e.g., two non-metals, diatomic elements)
- With reference to elements 1 to 20 on the periodic table, draw and interpret Bohr models, including protons, neutrons, and electrons, of
  - Atoms (neutral)
  - Ions (charged)
  - Molecules - covalent bonding (e.g., O\(_2\), CH\(_4\))
  - Ionic compounds (e.g., CaCl\(_2\))
- Identify valence electrons using the periodic table (excluding lanthanides and actinides)
- Distinguish between paired and unpaired electrons for a single atom
- Draw and interpret Lewis diagrams showing single bonds for simple ionic compounds and covalent molecules (e.g., NaCl, MgO, BaBr\(_2\), H\(_2\)O, CH\(_4\), NH\(_3\))
- Distinguish between lone pairs and bonding pairs of electrons in molecules
<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
</table>
| C2  classify substances as acids, bases, or salts, based on their characteristics, name, and formula | - identify acids and bases using indicators (e.g., methyl orange, bromthymol blue, litmus, phenolphthalein, indigo carmine)  
- explain the significance of the pH scale, with reference to common substances  
- differentiate between acids, bases, and salts with respect to chemical formulae and properties  
- recognize the names and formulae of common acids (e.g., hydrochloric, sulphuric, nitric, acetic)  
- use the periodic table to  
  - explain the classification of elements as metals and nonmetals  
  - identify the relative reactivity of elements in the alkali metal, alkaline earth metal, halogen, and noble gas groups  
  - distinguish between metal oxide solutions (basic) and non-metal oxide solutions (acidic)  
- use the periodic table and a list of ions (including polyatomic ions) to name and write chemical formulae for common ionic compounds, using appropriate terminology (e.g., Roman numerals)  
- convert names to formulae and formulae to names for covalent compounds, using prefixes up to “deca” |
| C3  distinguish between organic and inorganic compounds | - define organic compounds and inorganic compounds  
- distinguish between organic and inorganic compounds, based on their chemical structures  
- recognize a compound as organic or inorganic from its name, from its chemical formula, or from a diagram or model |
| C4  analyse chemical reactions, including reference to conservation of mass and rate of reaction | - define and explain the law of conservation of mass  
- represent chemical reactions and the conservation of atoms using molecular models  
- write and balance (using the lowest whole number coefficients) chemical equations from formulae, word equations, or descriptions of experiments  
- identify, give evidence for, predict products of, and classify the following types of chemical reactions:  
  - synthesis (combination)  
  - decomposition  
  - single and double replacement  
  - neutralization (acid-base)  
  - combustion  
- explain how factors such as temperature, concentration, presence of a catalyst, and surface area can affect the rate of chemical reactions |
### Prescribed Learning Outcomes

<table>
<thead>
<tr>
<th>C5</th>
<th>explain radioactivity using modern atomic theory</th>
</tr>
</thead>
</table>

### Suggested Achievement Indicators

- Define isotope in terms of atomic number and mass number, recognizing how these are communicated in standard atomic notation (e.g., Uranium-238: \( ^{238}_{92}U \))
- Relate radioactive decay (e.g., alpha – \( \alpha \), beta – \( \beta \), gamma – \( \gamma \)) to changes in the nucleus
- Relate the following subatomic particles to radioactive decay:
  - Proton (\( ^1_1p \))
  - Neutron (\( ^1_0n \))
  - Electron (\( ^0_{-1}e \))
  - Alpha particle (\( ^4_2\alpha \) (\( ^4_2He \))
  - Beta particle (\( ^0_{-1}\beta \))
- Explain half-life with reference to rates of radioactive decay
- Compare fission and fusion
- Complete and balance nuclear equations to illustrate radioactive decay, fission, and fusion
# Grade 10 Physical Science: Motion

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.</td>
</tr>
<tr>
<td>C6 explain the relationship of displacement and time interval to velocity for objects in uniform motion</td>
<td>Students who have fully met the Prescribed Learning Outcome are able to:</td>
</tr>
<tr>
<td></td>
<td>- define displacement (change in position, ( \Delta x )), time interval (( \Delta t )), and velocity (( v_{av} ))</td>
</tr>
<tr>
<td></td>
<td>- analyse graphically the relationship between displacement and time interval for an object travelling in uniform motion</td>
</tr>
<tr>
<td></td>
<td>- use the formula ( v_{av} = \Delta x/\Delta t ) to calculate the average velocity (( v_{av} )), displacement (change in position, ( \Delta x )), and time interval (( \Delta t )) for an object in uniform motion, given appropriate data</td>
</tr>
<tr>
<td></td>
<td>- design and conduct one or more experiments to determine the velocity of an object in uniform motion (e.g., using carts, balls, skateboards, bicycles, canoes in still water)</td>
</tr>
<tr>
<td>C7 demonstrate the relationship between velocity, time interval, and acceleration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- define acceleration (positive, negative, and zero)</td>
</tr>
<tr>
<td></td>
<td>- give examples of positive, negative, and zero acceleration, including</td>
</tr>
<tr>
<td></td>
<td>- falling objects</td>
</tr>
<tr>
<td></td>
<td>- accelerating from rest</td>
</tr>
<tr>
<td></td>
<td>- slowing down or stopping</td>
</tr>
<tr>
<td></td>
<td>- uniform motion</td>
</tr>
<tr>
<td></td>
<td>- given initial velocity (( v_i )), final velocity (( v_f )), and the time interval (( \Delta t )), calculate acceleration using the formula ( a = \Delta v/\Delta t ), where ( \Delta v = v_f - v_i ) (e.g., for falling objects)</td>
</tr>
</tbody>
</table>
**GRADE 10**

**KEY ELEMENTS: EARTH AND SPACE SCIENCE**

**Estimated Time: 20-25 hours**

By the end of the grade, students will have described the processes associated with energy transfer within the Earth’s geosphere and atmosphere and will have examined processes and features associated with plate tectonics.

*Energy Transfer in Natural Systems (11-14 hours)*

**Vocabulary**

atmosphere, conduction, convection, Coriolis effect, El Niño, greenhouse gases, heat, kilopascals, kinetic molecular theory, La Niña, ozone layer, permafrost, prevailing winds, thermal energy, tornado

**Knowledge**

- heat and thermal energy
- conduction and convection
- energy absorption and radiation in the atmosphere
- differential heating and prevailing winds
- changes in air density
- measurement of air pressure
- human and natural influences on climate
- climate affects natural systems

**Skills and Attitudes**

- illustrate energy transfer
- use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
**Key Elements: Earth and Space Science**

*Plate Tectonics (9-11 hours)*

**Vocabulary**
- asthenosphere
- continental drift theory
- converging/diverging plates
- earthquakes
- epicentre
- fault
- hot spot
- inner core
- lithosphere
- mantle
- mantle convection
- outer core
- paleoglaciation
- plate boundary
- plate tectonic theory
- primary waves
- ridge push and slab pull
- rift valley
- secondary waves
- spreading ridge
- subduction zone
- surface waves
- tectonic plate
- transform fault
- trench
- volcanic belt
- volcanic island arc
- volcanoes

**Knowledge**
- plate movement and associated features and processes
- diverging, converging, and transform plate boundaries
- deep-focus to shallow-focus earthquakes
- continental drift theory
- magnetic reversals

**Skills and Attitudes**
- illustrate plate movement
- identify tectonic mapping symbols
- use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
### Grade 10 Earth and Space Science: Energy Transfer in Natural Systems

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.</td>
</tr>
<tr>
<td>Students who have fully met the Prescribed Learning Outcome are able to:</td>
<td></td>
</tr>
<tr>
<td>D1 explain the characteristics and sources of thermal energy</td>
<td>- define heat and thermal energy</td>
</tr>
<tr>
<td></td>
<td>- explain and illustrate how thermal energy is transferred through conduction, convection, and radiation, with reference to</td>
</tr>
<tr>
<td></td>
<td>- kinetic molecular theory</td>
</tr>
<tr>
<td></td>
<td>- practical examples (e.g., home heating, cooking methods, loss of body heat, insulation)</td>
</tr>
<tr>
<td></td>
<td>- describe Earth’s energy sources including</td>
</tr>
<tr>
<td></td>
<td>- residual thermal energy from Earth’s formation</td>
</tr>
<tr>
<td></td>
<td>- energy from radioactive decay</td>
</tr>
<tr>
<td></td>
<td>- solar energy (with reference to absorption and radiation in the atmosphere)</td>
</tr>
<tr>
<td>D2 explain the effects of thermal energy within the atmosphere</td>
<td>- define atmospheric pressure and explain how it is measured</td>
</tr>
<tr>
<td></td>
<td>- identify weather conditions that typically accompany areas of low and high pressure in the atmosphere</td>
</tr>
<tr>
<td></td>
<td>- describe how energy transfer influences atmospheric convection, atmospheric pressure, and prevailing winds (e.g., differential heating of land and water causes changes in air density and affects prevailing winds)</td>
</tr>
<tr>
<td>D3 evaluate possible causes of climate change and its impact on natural systems</td>
<td>- describe how natural phenomena can affect climate (e.g., biosphere processes, volcanic eruptions, Coriolis effect, El Niño and La Niña)</td>
</tr>
<tr>
<td></td>
<td>- describe how climate can be influenced by human activities (e.g., greenhouse gases, depletion of ozone layer)</td>
</tr>
<tr>
<td></td>
<td>- describe how climate change affects natural systems (e.g., shrinking of the permafrost region, melting of ice shelves/caps/glaciers)</td>
</tr>
</tbody>
</table>
## Grade 10 Earth and Space Science: Plate Tectonics

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.</td>
</tr>
<tr>
<td></td>
<td>Students who have fully met the Prescribed Learning Outcome are able to:</td>
</tr>
</tbody>
</table>

**D4** analyse the processes and features associated with plate tectonics

- define plate tectonics, plate boundary, earthquake, trench, volcano, spreading ridge, subduction zone, hot spot
- relate tectonic plate movement to the composition of the following layers of the Earth, as determined by seismic waves (primary, secondary, and surface waves):
  - crust
  - lithosphere
  - asthenosphere
  - mantle
  - outer core
  - inner core
- describe tectonic plate boundaries, including
  - transform boundaries
  - divergent boundaries
  - convergent boundaries (oceanic-oceanic crust, oceanic-continental crust, and continental-continental crust)
- identify tectonic mapping symbols
- explain how plate movement produces the following features:
  - epicentres and shallow-focus to deep-focus earthquakes
  - volcanism at subduction zones (e.g., volcanic island arcs, volcanic belts) and at spreading ridges
  - mountain ranges and mid-ocean ridges
  - hot spot chains (e.g., Hawaiian Islands, Yellowstone)
- identify sources of heat within the Earth that produce mantle convection and hot spot activity (i.e., heat within the core and excess radioactivity within the mantle)
- explain how mantle convection and ridge push and slab pull are believed to contribute to plate motion

**D5** demonstrate knowledge of evidence that supports plate tectonic theory

- describe evidence for continental drift theory (e.g., fossil evidence, mountain belts, paleoglaciaion)
- relate the following to plate tectonic theory:
  - the world distribution of volcanoes, earthquakes, mountain belts, trenches, mid-ocean ridges, and rift valleys
  - hot spot and subduction zone eruptions
  - magnetic reversals and age of rocks relative to spreading ridges
CLASSROOM ASSESSMENT MODEL
The Classroom Assessment Model outlines a series of assessment units for Science 8 to 10. These units have been structured by grade level and according to the curriculum organizers:

- Life Science
- Physical Science
- Earth and Space Science

Processes of Science are integrated throughout the other three organizers. These units collectively address all of the Prescribed Learning Outcomes for Science 8 to 10.

This organization is not intended to prescribe a linear means of course delivery. Teachers are encouraged to address the learning outcomes in any order, and to combine and organize the units to meet the needs of their students and to respond to local requirements. Some students with special needs may have learning outcomes set for them that are modified and documented in their Individualized Education Plan (IEP). For more information, see the section on Inclusion, Equity, and Accessibility for All Learners in the Introduction to this IRP.

**CONSIDERATIONS FOR INSTRUCTION AND ASSESSMENT IN SCIENCE 8 TO 10**

It is highly recommended that parents and guardians be kept informed about all aspects of Science 8 to 10. For suggested strategies for involving parents and guardians, refer to the Introduction to this IRP.

Teachers are responsible for setting a positive classroom climate in which students feel comfortable learning about and discussing topics in Science 8 to 10. Guidelines that may help educators establish a positive climate that is open to free inquiry and respectful of various points of view can be found in the section on Establishing a Positive Classroom Climate in the Introduction to this IRP.

Teachers may also wish to consider the following:

- Involve students in establishing guidelines for group discussion and presentations.

Guidelines might include using appropriate listening and speaking skills, respecting students who are reluctant to share personal information in group settings, and agreeing to maintain confidentiality if sharing of personal information occurs.

- Promote critical thinking and open-mindedness, and refrain from taking sides on issues where there may be more than one point of view.

- Develop and discuss procedures associated with recording and using personal information that may be collected as part of students’ work for the purposes of instruction and/or assessment (e.g., why the information is being collected, what the information will be used for, where the information will be kept; who can access it—students, administrators, parents; how safely it will be kept).

- Ensure students are aware that if they disclose personal information that indicates they are at risk for harm, then that information cannot be kept confidential. For more information, see the section on Confidentiality in the Introduction to this IRP.

**Classroom Assessment and Evaluation**

Teachers should consider using a variety of assessment techniques to assess students’ abilities to meet the Prescribed Learning Outcomes. Tools and techniques for assessment in Science 8 to 10 can include:

- teacher assessment tools such as observation checklists, rating scales, and scoring guides
- self-assessment tools such as checklists, rating scales, and scoring guides
- peer assessment tools such as checklists, rating scales, and scoring guides
- journals or learning logs
- video (to record and critique student demonstration)
- written tests, oral tests (true/false, multiple choice, short answer)
- worksheets
- portfolios
- student-teacher conferences
Assessment in Science 8 to 10 can also occur while students are engaged in, and based on the product of, activities such as:

- case studies and simulations
- group and class discussions
- brainstorming, clusters, web
- research projects
- role plays
- charts and graphs
- posters, collages, models, web sites
- oral and multimedia presentations
- peer teaching
- personal pledges or contracts

For more information about student assessment, refer to the section on Student Achievement.

**Information and Communications Technology**

The Science 8 to 10 curriculum requires students to be able to use and analyse the most current information to make informed decisions on a range of topics. This information is often found on the Internet as well as in other information and communications technology resources. When organizing for instruction and assessment, Science 8 to 10 teachers should consider how students will best be able to access the relevant technology, and ensure that students are aware of school district policies on Internet and computer use.

**Contents of the Model**

**Assessment Overview Table**

The Assessment Overview Table provides teachers with suggestions and guidelines for assessment of each grade of the curriculum. This table identifies the domains of learning and cognitive levels of the learning outcomes, along with a listing of suggested assessment activities and a suggested weight for grading for each curriculum organizer.

**Key Elements**

This section includes a brief description of the unit, identifying relevant vocabulary, knowledge, skills, and attitudes.

**Suggested Timeframe**

The suggested time indicates the average number of hours needed to address the Prescribed Learning Outcomes identified in that unit; it does not necessarily indicate the time required to implement the suggested instructional and assessment activities listed.

**Prescribed Learning Outcomes and Suggested Achievement Indicators**

Each set of Prescribed Learning Outcomes identifies the content standards for that unit. The corresponding Achievement Indicators provide additional information about the expected level or degree of student performance and can be used as the basis for assessment.

**Suggested Planning and Assessment Activities**

Planning and assessment activities have been included for each Prescribed Learning Outcome and set of corresponding Achievement Indicators. Each suggested assessment activity directly corresponds to a particular planning activity as indicated by the order and arrangement of these activities.

A wide variety of planning (instructional) activities has been included to address a variety of learning and teaching styles. The assessment activities describe a variety of tools and methods for gathering evidence of student performance.

These strategies are suggestions only, designed to provide guidance for teachers in planning and carrying out assessment to meet the Prescribed Learning Outcomes. Criteria identified are likewise suggested only and may not always be directly referenced in a Prescribed Learning Outcome.

**Recommended Learning Resources**

This section lists the Science 8 to 10 recommended learning resources that relate to the specific learning outcomes in each topic. The resources listed do not necessarily relate to the suggested instruction and assessment. Teachers may choose to use these resources, or they may use other
locally approved resources. See the section on Recommended Learning Resources in this IRP for more information.

As new resources are recommended, information will be posted on the ministry website: http://www.bced.gov.bc.ca/irp_resources/ir/resource/consub.htm

Assessment Instruments
Sample assessment instruments have been included at the end of each unit, and are provided to help teachers determine the extent to which students are meeting the Prescribed Learning Outcomes. These instruments contain criteria specifically keyed to one or more of the suggested assessment activities contained in the unit. These criteria are suggested only and may not always be directly referenced in a Prescribed Learning Outcome.
CLASSROOM ASSESSMENT MODEL

Grade 10
**GRADE 10: ASSESSMENT OVERVIEW TABLE**

The purpose of this table is to provide teachers with suggestions and guidelines for formative and summative classroom-based assessment and grading of Grade 10 Science.

<table>
<thead>
<tr>
<th>Curriculum Organizers/ Suborganizers</th>
<th>Suggested Assessment Activities</th>
<th>Suggested Weight for Grading</th>
<th>Number of Outcomes</th>
<th>Number of Outcomes by Domain*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>U&amp;A</td>
</tr>
<tr>
<td><strong>PROCESSES OF SCIENCE</strong></td>
<td>• integrated throughout – assessed in relation to performance tasks associated with each of the other organizers</td>
<td>30%</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td><strong>LIFE SCIENCE</strong></td>
<td>• demonstrating • summarizing • comparing • diagramming &amp; illustrating • observing/reporting (e.g., lab report)</td>
<td>20%</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>PHYSICAL SCIENCE</strong></td>
<td>• demonstrating • experimenting • diagramming &amp; illustrating • observing/reporting (e.g., lab report)</td>
<td>30%</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td><strong>EARTH AND SPACE SCIENCE</strong></td>
<td>• explaining • diagramming &amp; illustrating • observing/reporting (e.g., field study)</td>
<td>20%</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td>100%</td>
<td>22</td>
<td>2</td>
</tr>
</tbody>
</table>

* The following abbreviations are used to represent the three cognitive levels within the cognitive domain: K = Knowledge; U&A = Understanding and Application; HMP = Higher Mental Processes; AFF = Affective domain.
GRADE 10 PROCESSES OF SCIENCE

KEY ELEMENTS: PROCESSES OF SCIENCE

Estimated Time: integrate with other curriculum organizers
The Prescribed Learning Outcomes related to Processes of Science support the development of attitudes, skills, and knowledge essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other three curriculum organizers.

Vocabulary
accuracy, conclusion, control, controlled experiment, dependent variables, hypothesis, independent variables, observation, precision, prediction, procedure, principle, scientific literacy, uncertainty, validity, variable

Knowledge
- metric system (SI units)
- elements of a valid experiment
- dependent and independent variables
- appropriate scale
- application of scientific principles in the development of technologies

Skills and Attitudes
- recognize dangers
- demonstrate emergency response procedures
- use personal protective equipment
- use proper techniques for handling and disposing of lab materials
- use the Bunsen burner and hotplate
- make accurate measurements using a variety of instruments (e.g., rulers, balances, graduated cylinders)
- use the Internet as a research tool
- communicate results
- use appropriate types of graphic models and/or formulae to represent a given type of data, including the Bohr model
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- deduce relationships between variables given a graph or by constructing graphs
- use models to demonstrate how systems operate
- apply given criteria for evaluating evidence and sources of information
- identify main points, supporting or refuting information, and bias in a science-related article or illustration
- demonstrate ethical, responsible, cooperative behaviour
- acquire and apply scientific and technological knowledge to the benefit of self, society, and the environment
### Grade 10 Processes of Science

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A1</strong> demonstrate safe procedures</td>
<td>It is expected that students will:</td>
</tr>
<tr>
<td></td>
<td>- identify a variety of dangers in procedures (e.g., cuts from sharp objects; explosions or burns from handling chemicals or heating materials)</td>
</tr>
<tr>
<td></td>
<td>- identify appropriate equipment for an lab activity (e.g., Bunsen burner vs. hotplate; glassware for chemicals)</td>
</tr>
<tr>
<td></td>
<td>- identify and use appropriate personal protective equipment (e.g., hand and eye protection) and procedures (e.g., hair tied back, clear work area, no loose clothing, no horseplay)</td>
</tr>
<tr>
<td></td>
<td>- use proper techniques for handling and disposing of lab materials (e.g., using special containers for caustic chemicals)</td>
</tr>
<tr>
<td></td>
<td>- describe appropriate emergency response procedures (e.g., how to use a fire extinguisher/blanket, eye wash station, first aid for cuts and burns, knowing who to contact and how)</td>
</tr>
</tbody>
</table>

| **A2** perform experiments using the scientific method | - describe the elements of a valid experiment: |
| | - formulate an hypothesis |
| | - make a prediction |
| | - identify controlled versus experimental variables |
| | - observe, measure, and record using appropriate units |
| | - interpret data |
| | - draw conclusions |
| | - use information and conclusions as a basis for further comparisons, investigations, or analyses |
| | - communicate results using a variety of methods |

<p>| <strong>A3</strong> represent and interpret information in graphic form | - identify and use the most appropriate type of graphic, model, or formula to convey information, including |
| | - Bohr model or diagram |
| | - convection model or diagram |
| | - Lewis diagrams |
| | - chemical formulae |
| | - line graphs of displacement, time interval, and velocity |
| | - diagrams (e.g., food webs/pyramids, nutrient cycles, plate boundaries) |
| | - distinguish between dependent and independent variables in a graph |
| | - use appropriate scale and axis to create a graph |
| | - extrapolate and interpolate points on a graph |
| | - extract information from maps, bar graphs, line graphs, tables, and diagrams (e.g., periodic table) |</p>
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</table>
| A4  demonstrate scientific literacy | - identify the main points in a science-related article or illustration  
- describe the qualities of the scientifically literate person, such as  
  - awareness of assumptions (their own and authors’)  
  - respect for precision  
  - ability to separate fundamental concepts from the irrelevant or unimportant  
  - recognizing that scientific knowledge is continually developing and often builds upon previous theories  
  - recognizing cause and effect  
- use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)  
- explain how science and technology affect individuals, society, and the environment |
| A5  demonstrate ethical, responsible, cooperative behaviour | - describe and demonstrate  
  - ethical behaviour (e.g., honesty, fairness, reliability)  
  - open-mindedness (e.g., ongoing examination and reassessment of own beliefs)  
  - willingness to question and promote discussion  
  - skills of collaboration and co-operation  
  - respect for the contributions of others |
| A6  describe the relationship between scientific principles and technology | - give examples of scientific principles that have resulted in the development of technologies (e.g., velocity/acceleration—technologies related to transportation and athletics)  
- identify a variety of technologies and explain how they have advanced our understanding of science (e.g., seismographic instruments and GPS—plate tectonics and Earth’s layers) |
| A7  demonstrate competence in the use of technologies specific to investigative procedures and research | - select and carefully use balances and other measurement tools (e.g., thermometers, timing devices, electronic devices)  
- proficiently use the Internet as a research tool |
# Grade 10

## Key Elements: Life Science

Estimated Time: 20-25 hours

By the end of the grade, students will have assessed the significance of natural phenomena and human factors within ecosystems.

### Vocabulary

- abiotic, aeration, adaptive radiation, bioaccumulation, biodegradation, biome, biotic, climax community, carbonate, commensalism, decomposers, denitrification, ecological succession, ecosystem, food chains, food pyramids, food webs, heavy metals, keystone species, lightning, mutualism, nitrification, natural selection, nutrients, parasitism, PCBs, pesticides, pH, phosphorus, photosynthesis, potassium, predation, proliferation, symbiosis, trophic levels

### Knowledge

- abiotic and biotic elements in ecosystems
- cycling of carbon, nitrogen, oxygen, and phosphorus
- ecosystems with similar characteristics in different geographical locations
- effects of altering an abiotic factor
- species adaptation
- food webs and pyramids
- mechanisms and possible impacts of bioaccumulation
- traditional ecological knowledge (TEK)
- impact of natural phenomena, foreign species, disease, pollution, habitat destruction, and exploitation of resources on ecosystems

### Skills and Attitudes

- use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
- formulate a reasoned position
- demonstrate ethical behaviour
- relate cause to effect
- assess human impact
- show respect and sensitivity for the environment
- conduct experiments
**GRADE 10: LIFE SCIENCE: SUSTAINABILITY OF ECOSYSTEMS**

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
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<tbody>
<tr>
<td><em>It is expected that students will:</em></td>
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<tr>
<td>B1 explain the interaction of abiotic and biotic factors within an ecosystem</td>
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<table>
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<tr>
<th>Suggested Achievement Indicators</th>
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<tr>
<td><em>The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:</em></td>
</tr>
</tbody>
</table>

- define abiotic, biotic, biome, and ecosystem
- identify distinctive plants, animals, and climatic characteristics of Canadian biomes (tundra, boreal forest, temperate deciduous forest, temperate rainforest, grasslands)
- identify biotic and abiotic factors in a given scenario or diagram
- describe the relationships between abiotic and biotic elements within an ecosystem, including
  - air, water, soil, light, temperature (abiotic)
  - bacteria, plants, animals (biotic)
- design and analyse experiments on the effects of altering biotic or abiotic factors (e.g., nutrients in soil: compare two plant types with the same nutrients, compare one plant type with different nutrients)
- explain various relationships with respect to food chains, food webs, and food pyramids, including
  - producer
  - consumer (herbivore, carnivore, omnivore)
  - predation (predator-prey cycle)
  - decomposers
  - symbiosis (mutualism, commensalism, parasitism)
- illustrate the cycling of matter through abiotic and biotic components of an ecosystem by tracking
  - carbon (with reference to carbon dioxide – CO₂, carbonate CO₃²⁻, oxygen – O₂, photosynthesis, respiration, decomposition, volcanic activity, carbonate formation, greenhouse gases from human activity, combustion)
  - nitrogen (with reference to nitrate – NO₃⁻, nitrite – NO₂⁻, ammonium – NH₄⁺, nitrogen gas – N₂, nitrogen fixation, bacteria, lightning, nitrification, denitrification, decomposition)
  - phosphorus (with reference to phosphate – PO₄³⁻, weathering, sedimentation, geological uplift)
- identify factors that affect the global distribution of the following biomes: tropical rainforest, temperate rainforest, temperate deciduous forest, boreal forest, grasslands, desert, tundra, polar ice
- using examples, explain why ecosystems with similar characteristics can exist in different geographical locations (i.e., significance of abiotic factors)
- identify the effects on living things within an ecosystem resulting from changes in abiotic factors, including
  - climate change (drought, flooding, changes in ocean current patterns, extreme weather)
  - water contamination
  - soil degradation and deforestation

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<tr>
<td>• Review students’ knowledge of ecosystems by having them Think-Pair-Share, in order to create a concept map that incorporates the concepts biotic, abiotic, biome, ecosystem, food chain, food webs, and food pyramids.</td>
<td>• Assess concept maps with regards to accuracy of the relationships between the concepts. Assess students’ work according to the criteria outlined in the sample assessment instrument provided at the end of this grade, Concept Maps.</td>
</tr>
</tbody>
</table>
- Through direct instruction, explain the various relationships (e.g., mutualism, commensalism, parasitism, predation, decomposers) that can exist in food chains and food webs.

- Students could be asked to identify relationships from various pictures/photos (that you provide, or students are asked to find) that depict the various types of relationships and provide a rationale as to why they made that selection.

- Have students work in groups to design an experiment to investigate the effects of altering abiotic factors. Examples of labs could include
  - plants grown in soils with varying nutrient levels
  - earthworms or woodbugs reacting to light, moisture, or soil type

- Have students prepare a detailed lab report based on their findings of their experiment. [rubric] Have students create a poster, storyboard, or multimedia presentation to share their lab findings for the rest of the class.

- Have students conduct a lab that investigates “A Decaying Log Community.” This might be a field trip or an independent activity. Ask students:
  - After locating a suitable log in its natural habitat, describe its location, and describe what evidence suggests that the log is decayed.
  - Make observations and sketches recording the types and numbers of plants and animals that are observed living on, in, or under the log.

- Ask students to prepare a lab report based on their findings. In their analysis of their results they should answer the following questions:
  - What plants and animals were the most abundant?
  - In what ways do plants and animals depend upon the log for life?
  - Not all organisms living in this community were identified. Explain.
  - Design a food web for the organisms you identified in the decaying log community, making sure to identify the type of relationships. You will need to research this information.

- Discuss with students the ways in which nutrients are cycled through the ecosystem. Use diagrams and flowcharts to illustrate the detailed cycling of carbon, nitrogen, oxygen and phosphorus. Use prompting questions such as:
  - What happens to the bodies of dead organisms?
  - How are the bodies of dead organisms reused and recycled in the environment?
  - What is fertilizer?

- Assess students on their understanding of the nutrient cycles, based on their responses to the following:
  - Explain how photosynthesis and cell respiration affect the carbon cycle.
  - Describe the relationship between the carbon and oxygen cycle.
  - Explain why some farmers alternate legumes with their regular crops.
- Using climate information provided or researched from various locations around the globe, ask students to create climatographs that graph temperature and precipitation. They can then relate the climatographs to their ecosystem/biome.

- Have students create climatographs depicting information from two or more locations from the same biome, as well as from two different biomes. Have them complete a comparison chart for all locations to note:
  - abiotic factors that are similar
  - abiotic factors that are different
  - the results of these similarities and differences on ecosystems.

- Have students work independently or in groups to find recent articles depicting cases of how changes in abiotic factors (e.g., drought, flooding, changes in ocean current patterns, extreme weather, water contamination) have impacted on living things—with an emphasis on humans—within a particular ecosystem.

- Have students create a storyboard to depict how changes in abiotic factors have affected an ecosystem. You could adapt the assessment tool for storyboard work supplied at the end of the Classroom Model for this grade (Storyboard for Covalent and Ionic Compound Formation) to assess student work. Alternatively, students can create cause-and-effect graphic organizers to illustrate their understanding.
# Grade 10: Life Science: Sustainability of Ecosystems

## Prescribed Learning Outcomes

It is expected that students will:

- **B2** assess the potential impacts of bioaccumulation

## Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define, using examples, the terms *bioaccumulation, parts per million (ppm), biodegradation, and trophic levels* (with reference to producers and to primary, secondary, and tertiary consumers)
- identify a variety of contaminants that can bioaccumulate (e.g., pesticides, heavy metals, PCBs)
- describe the mechanisms and possible impacts of bioaccumulation (e.g., eradication of keystone species, reproductive impacts)
- compare the impact of bioaccumulation on consumers at different trophic levels (e.g., red tide in oysters and humans; heavy metals in fish and humans; PCBs in fish, birds, whales)
- research and analyse articles on the causes and effects of bioaccumulation (e.g., mercury contamination in Inuit communities and the Grassy Narrows First Nation community)

## Planning for Assessment

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| • Provide direct instruction, illustrations, and examples to define bioaccumulation, parts per million (ppm), biodegradation, and trophic levels. | • Have students complete a vocabulary development chart for the terms *bioaccumulation, parts per million (ppm), biodegradation, and trophic levels*. Look for evidence that students are able to provide
| | - accurate definitions
| | - three examples of each term
| | - three analogies (“What is it like?”) for each term
| | - details about the various trophic levels (i.e., producers, primary consumers, secondary consumers, and tertiary consumers)
| • Have students conduct research to identify case studies of how contaminants (e.g., red tide in oysters and humans on the Pacific coast; heavy metals such as mercury in Inuit communities and Grassy Narrows First Nation community; PCBs in fish, birds, whales in the St. Lawrence) have bioaccumulated. | • Have students create a cartoon to describe the mechanism and impacts of bioaccumulation within the ecosystem’s food web. Assess students’ cartoons, looking for
| | - appropriate selection of a case study
| | - correct depiction of the bioaccumulation
| | - analysis of the effects of bioaccumulation on the food web
| | - include reference to trophic levels
| | - creativity in illustrating the facts in a cartoon format. |
GRADE 10: LIFE SCIENCE: SUSTAINABILITY OF ECOSYSTEMS

Prescribed Learning Outcomes

It is expected that students will:
B3 explain various ways in which natural populations are altered or kept in equilibrium

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- explain how species adapt or fail to adapt to environmental conditions, with reference to the following:
  - natural selection
  - proliferation
  - predator/prey cycle
  - ecological succession
  - climax community
  - extinction
  - adaptive radiation
- describe the impact of natural phenomena (e.g., drought, fire, temperature change, flooding, tsunamis, infestations—pine beetle, volcanic eruptions) on ecosystems
- give examples of how foreign species can affect an ecosystem (e.g., Eurasian milfoil, purple loosestrife, scotch broom, American bullfrog, European starling in BC)
- give examples of how traditional ecological knowledge (TEK) can affect biodiversity (e.g., spring burning by Cree in northern Alberta)
- research and report on situations in which disease, pollution, habitat destruction, and exploitation of resources affect ecosystems

Planning for Assessment

- Set up a gallery walk depicting examples of how species adapt or fail to adapt to environmental conditions, including natural selection, proliferation, predator/prey cycle, ecological succession, climax community, extinction and adaptive radiation. At each example, have students identify
  - which type(s) of adaptation applies to the example
  - identify both the positive and negative aspects of the case for the species.
- Have students research specific examples of ecosystems that have changed as a result of natural phenomena, introduction of species, or traditional ecological knowledge. Case examples could include
  - volcanic activity producing deadly gases which have been released from lakes in Cameroon
  - drought in Ethiopia or Sudan
  - forest fires in California, Portugal, or

Assessment Strategies

- Follow up the gallery walk activity with a class discussion. Conclude by having students write a summative statement about each type of adaptation. Look for evidence that they are able to
  - define each term accurately
  - use supporting evidence from the gallery walk case studies.
- Have students compile the results of their research in an electronic slide show or other multimedia presentation. Students’ presentations should address the following questions:
  - Was this effect purposeful or accidental?
  - What was its effect on the native species within the ecosystems?
  - Was this a result of natural or human activity?
  - Was this event cyclical (i.e., predictable) or unpredictable?
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<th>Kelowna</th>
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<tbody>
<tr>
<td>- flooding in Bangladesh or India</td>
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<td>- tsunami in Aceh, Malaysia, or Thailand</td>
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<tr>
<td>- infestation of locusts in African countries</td>
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<tr>
<td>- purposeful or accidental introduction of</td>
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<tr>
<td>species such as Purple loosestrife,</td>
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<tr>
<td>American bullfrog, European starlings in</td>
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<tr>
<td>North America, deer on the Queen</td>
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<tr>
<td>Charlotte Islands, Eurasian milfoil, Scotch</td>
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<tr>
<td>broom, zebra mussels in the Great Lakes</td>
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<td>- practices of traditional ecological</td>
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<td>knowledge such as spring burning by</td>
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<tr>
<td>Cree in northern Alberta</td>
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</table>

- Invite a guest speaker (e.g., Aboriginal Elder, wildlife protection officer, zoologist) to talk about how disease, pollution, habitat destruction, or resource exploitation have affected a local ecosystem, and the efforts to counter those effects. Where possible, follow up with a field trip to the ecosystem.

- Have students write a newspaper article about the case presented by the guest speaker. Students should be able to
  - articulate short-term and long-term effects on various species populations
  - identify positive and negative effects on the ecosystem
  - reference applicable terms such as equilibrium, abiotic, biotic, predator, prey, succession, extinction, climax community, or proliferation
## Grade 10

### Key Elements: Physical Science

**Estimated Time: 40-45 hours**

By the end of the grade, students will have demonstrated understanding of chemical reactions and radioactivity, and explained motion in terms of displacement, time interval, velocity, and acceleration.

*Chemical Reactions and Radioactivity (30 hours)*

**Vocabulary**

acids, alpha particle, atomic number, atoms, bases, beta particle, Bohr diagrams, bromothymol blue, catalyst, combustion, compounds, concentration, conservation of mass, covalent bonding, decomposition, electron, fission, fusion, gamma radiation, half-life, indigo carmine, inorganic, ionic bonding, ions, isotope, Lewis diagrams, light, litmus paper, mass number, methyl orange, molecules, neutralization (acid-base), neutron, organic, phenolphthalein, polyatomic, proton, radioactive decay, salts, single and double replacement, surface area, symbolic equations, synthesis, valence electron

**Knowledge**

- acids, bases, and salts
- common ionic and covalent compounds
- organic and inorganic compounds
- chemical reactions (synthesis, decomposition, single and double replacement, neutralization, combustion)
- conservation of mass
- radioactivity

**Skills and Attitudes**

- draw and interpret Bohr models
- draw and interpret Lewis diagrams for compounds containing single bonds
- name and write chemical formulae for common ionic and covalent compounds, using appropriate terminology
- use standardized tests for acids and bases
- write and balance chemical equations
- write and balance nuclear equations
- use molecular models
- use the periodic table and ion charts
- demonstrate respect for precision
## Key Elements: Physical Science

### Motion (10-15 hours)

#### Vocabulary
- acceleration, displacement, slope, time interval, uniform motion, velocity

#### Knowledge
- relationship of displacement and time interval to velocity
- motion of objects
- uniform motion
- acceleration due to gravity
- acceleration: positive, negative, and zero

#### Skills and Attitudes
- calculate using $v_{fn} = \Delta x/\Delta t$
- calculate using $a = \Delta v/\Delta t$, where $\Delta v = v_f - v_i$
- demonstrate respect for precision
# Grade 10 Physical Science: Chemical Reactions and Radioactivity

## Prescribed Learning Outcomes

*It is expected that students will:*

| Cl | Differentiate between atoms, ions, and molecules using knowledge of their structure and components |

## Suggested Achievement Indicators

*The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:*

- **demonstrate knowledge of the three subatomic particles, their properties, and their location within the atom (e.g., by creating models)**
- **define and give examples of ionic bonding (e.g., metal and non-metal) and covalent bonding (e.g., two non-metals, diatomic elements)**
- **with reference to elements 1 to 20 on the periodic table, draw and interpret Bohr models, including protons, neutrons, and electrons, of**
  - atoms (neutral)
  - ions (charged)
  - molecules - covalent bonding (e.g., \( \text{O}_2 \), \( \text{CH}_4 \))
  - ionic compounds (e.g., \( \text{CaCl}_2 \))
- **identify valence electrons using the periodic table (excluding lanthanides and actinides)**
- **distinguish between paired and unpaired electrons for a single atom**
- **draw and interpret Lewis diagrams showing single bonds for simple ionic compounds and covalent molecules (e.g., \( \text{NaCl} \), \( \text{MgO} \), \( \text{BaBr}_2 \), \( \text{H}_2\text{O} \), \( \text{CH}_4 \), \( \text{NH}_3 \))**
- **distinguish between lone pairs and bonding pairs of electrons in molecules**

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<td>• Review with students the charge, mass, and location of the three subatomic particles.</td>
<td>• Have students complete a fishbone diagram with information on protons, neutrons, and electrons, then trade with a partner for peer assessment, focussing on correct and complete inclusion of - name of the particle - relative mass - relative charge - location in the atom and symbol.</td>
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<td>• Review the concept of isotopes, standard atomic notation, atomic number, number of neutrons, and mass number. Provide students with terms and definitions, and challenge them to match each term to its definition (e.g., cutting and pasting from a handout, matching index cards, playing a “who am I” game).</td>
<td>• Have students use their notebooks to provide definitions and examples of each term discussed. Criteria for assessment could include - correct matching of the term and definition - quality of the example provided.</td>
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<tr>
<td>• Provide students with definitions and examples of ionic compounds and covalent compound, and the types of bonds that occur within these molecules. Explain to students how these different types of bonds form.</td>
<td>• Have students classify a variety of compounds into ionic or covalent. Have them work in pairs to develop an analogy to explain ionic and covalent compound formation and record this in their notebooks. Students can present their analogies to</td>
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### Classroom Assessment Model • Grade 10

| | the class. Analogies should emphasize the following: |
| | - ionic compounds: transfer of electrons between metal and non-metal atoms to form ions; oppositely charged ions are attracted to each other and form a bond |
| | - covalent compounds: similar types of atoms combining and electrons being shared in bond formation. |

- Have students Think-Pair-Share their knowledge of Bohr diagrams of elements and ions from grade 9.
- Have students draw Bohr diagrams of molecules—both covalent (where electrons are shared) and ionic (where electrons are transferred from one atom to another).

- Ask students to create a storyboard, showing the progressive steps in ionic and covalent compound formation. The steps involved should show:
  - atoms involved
  - loss/gain or transfer of electrons
  - molecule produced
  - Assess students’ work using criteria such as those outlines in the sample assessment instrument provided at the end of this grade (Storyboard for Covalent and Ionic Compound Formation).

- Have students research the concept of *valence electrons* (electrons that take part in chemical reactions/electrons that are beyond the previous noble gas arrangement/electrons that are in open shells).

- Have students draw Lewis diagrams for first 20 elements on a blank template of the periodic table, (element symbol surrounded by valence electrons). Look for evidence that students are able to complete the template accurately following these rules:
  - First 20 elements are included and correctly placed.
  - Electrons are placed around the element symbols at the points of the compass (N-E-S-W).
  - Electrons are placed singly, until five is reached, when they are paired.

- Present students with sufficient information to draw Lewis diagrams of molecules. Point out that only unpaired electrons can participate in bonding. Have students practise drawing Lewis diagrams for covalent molecules. Initially, students should be given a structural formula. Have students draw Lewis structures for ionic compounds using metallic and non-metallic elements.

- Administer a quiz to assess students’ knowledge. Questions could focus on concepts such as:
  - ability to draw Lewis diagrams for covalent molecules such as H₂O and CH₄
  - ability to draw Lewis diagrams for ionic molecules such as NaBr and BaCl₂.
### Prescribed Learning Outcomes

It is expected that students will:

- **C2** classify substances as acids, bases, or salts, based on their characteristics, name, and formula.

### Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- **Identify acids and bases using indicators (e.g., methyl orange, bromthymol blue, litmus, phenolphthalein, indigo carmine)**
- **Explain the significance of the pH scale, with reference to common substances**
- **Differentiate between acids, bases, and salts with respect to chemical formulae and properties**
- **Recognize the names and formulae of common acids (e.g., hydrochloric, sulphuric, nitric, acetic)**
- **Use the periodic table to**
  - Explain the classification of elements as metals and nonmetals
  - Identify the relative reactivity of elements in the alkali metal, alkaline earth metal, halogen, and noble gas groups
  - Distinguish between metal oxide solutions (basic) and non-metal oxide solutions (acidic)**
- **Use the periodic table and a list of ions (including polyatomic ions) to name and write chemical formulae for common ionic compounds, using appropriate terminology (e.g., Roman numerals)**
- **Convert names to formulae and formulae to names for covalent compounds, using prefixes up to “deca”**

### Planning for Assessment

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<td>• Have students perform an experiment to distinguish acids, bases and salts using indicators (e.g., Litmus paper, phenolphthalein, and bromthymol blue). Use hydrochloric, sulphuric, nitric, acetic and others.</td>
<td>• Ask students to write up the lab, using a prescribed format such as the one provided in the sample assessment instrument (Lab Report) provided at the end of this grade. Collect students’ completed reports and assess for thoroughness and accuracy according to the criteria provided in the outline.</td>
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<tr>
<td>• Ask students to observe the names and formulae of acids, bases, and salts to look for commonalities.</td>
<td>• Have students use their notebooks to note the commonalities they observe. Collect their notebooks, looking for evidence that they have identified acidic solutions contain H⁺ ions, basic OH⁻ ions. Salt solutions contain a metal ion and a non-metal ion (other than H⁺ and OH⁻).</td>
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<tr>
<td>• Have students undertake research and conduct experiments to determine the other properties of acids, bases, and salts: solubility in water, conductivity (using conductivity apparatus), reactivity with metals, carbonates and bicarbonates, etc.</td>
<td>• After performing the lab and/or research, students can work in pairs to construct a Venn diagram as an assessment instrument to summarize their information on acids, bases, and salts. Have students conduct a peer assessment of each others’ work, looking for the correct identification of properties of acids</td>
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</table>
Caution: students should be reminded not to taste or touch chemicals in the laboratory, even though taste and touch may be distinguishing properties.

- Provide students with information about specific physical and chemical properties of groups of elements on the periodic table, including:
  - types of reactivity (e.g., metal oxides produce bases in water, non-metal oxides produce acids in water)
  - trends through the representative elements and transition elements.

- Students can construct a concept map of the periodic table containing the information. Assess their work using criteria such as those outlined in the sample assessment instrument (Concept Map) provided at the end of the Classroom Model for this grade.

- Review with students how to write names and formulae for ionic compounds. Provide worksheets for students to practise. To make the practice as relevant as possible, share with students the uses of many of the compounds. Use the opportunity to reinforce their knowledge of acids and bases. As well, explain the procedure for naming acids:
  - $\text{HCl} - \text{hydrogen chloride}$
  - $\text{H}_2\text{CO}_3 - \text{hydrogen carbonate}$
  - $\text{H}_2\text{CO}_3\text{(aq)} - \text{carbonic acid}$
  - $\text{H}_2\text{SO}_3 - \text{hydrogen sulphite}$
  - $\text{H}_2\text{SO}_4\text{(aq)} - \text{sulphurous acid}$.

- Use a quiz or series of quizzes to check students’ proficiency. Quiz could include questions related to
  - naming compounds given the formulae (e.g., $\text{NaCl}$, $\text{HBr}\text{(aq)}$, $\text{Li}_2\text{PO}_4$)
  - writing formulae given the names of compounds (e.g., iron (III) chloride, perchloric acid, barium nitrate).

- Introduce students to the procedure used to write the names and formulae for covalent compounds, and allow students to practise examples. Again, to make the practice as relevant as possible, share with students the uses and occurrences of many of the compounds (e.g., carbon monoxide, CO, is found in automobile exhaust).

- Have students develop and play a card game to write names and formulae for covalent compounds. To assess the games use the following criteria:
  - all prefixes 1 to 10 are included on “number of atom” cards
  - only non-metal elements are used on “element” cards
  - students have established clear rules for their game
  - students have determined a means of recording answers and/or a point scoring system.
GRADE 10 PHYSICAL SCIENCE: CHEMICAL REACTIONS AND RADIOACTIVITY

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<tbody>
<tr>
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<tr>
<td>C3 distinguish between organic and inorganic compounds</td>
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<tr>
<td>- define organic compounds and inorganic compounds</td>
</tr>
<tr>
<td>- distinguish between organic and inorganic compounds, based on their chemical structures</td>
</tr>
<tr>
<td>- recognize a compound as organic or inorganic from its name, from its chemical formula, or from a diagram or model</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLANNING FOR ASSESSMENT</th>
<th>ASSESSMENT STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Have students research the similarities and differences between organic and inorganic compounds.</td>
<td>• Have students complete a chart illustrating the similarities and differences between organic and inorganic compounds. Assess charts to determine if they include</td>
</tr>
<tr>
<td></td>
<td>- composition (chemical structures)</td>
</tr>
<tr>
<td></td>
<td>- uses and occurrences</td>
</tr>
<tr>
<td></td>
<td>- types of bonding involved</td>
</tr>
<tr>
<td></td>
<td>- relationship to living things.</td>
</tr>
<tr>
<td>• Have students research a particular group of organic compounds; antibiotics, drugs, herbicides/pesticides, fabrics (fibres), explosives or a particular organic compound (e.g., Teflon, PABA [sunscreen], motor oil).</td>
<td>• Ask students to prepare and deliver a 4-5 slide presentation on the discovery, development, uses, benefits, and drawbacks of using selected organic compounds. Use criteria such as those outlined in the sample assessment instrument (Slide Presentation) provided at the end of this grade.</td>
</tr>
<tr>
<td>• Supply students with a collection of names, formulae, and diagrams for various organic and inorganic compounds. Have students individually participate in a sorting activity to classify them as either organic or inorganic.</td>
<td>• Have students work in pairs to discuss each others’ sorted lists and identify items on which they disagreed when sorting. Then spend time as a whole class discussing the compounds that students had difficulty sorting. Correct misconceptions. Subsequently conduct another similar sorting activity, focusing on names, formulae or diagrams similar to those that students had difficulty with the first time.</td>
</tr>
</tbody>
</table>
GRADE 10 PHYSICAL SCIENCE: CHEMICAL REACTIONS AND RADIOACTIVITY

Prescribed Learning Outcomes

It is expected that students will:
C4 analyse chemical reactions, including reference to conservation of mass and rate of reaction

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define and explain the law of conservation of mass
- represent chemical reactions and the conservation of atoms using molecular models
- write and balance (using the lowest whole number coefficients) chemical equations from formulae, word equations, or descriptions of experiments
- identify, give evidence for, predict products of, and classify the following types of chemical reactions:
  - synthesis (combination)
  - decomposition
  - single and double replacement
  - neutralization (acid-base)
  - combustion
- explain how factors such as temperature, concentration, presence of a catalyst, and surface area can affect the rate of chemical reactions

PLANNING FOR ASSESSMENT

- Have students investigate the Law of Conservation of Mass by performing a lab in which mass appears to be lost (e.g., baking soda and vinegar), gained (e.g., burning magnesium), and stays the same.
- Ask students to write and balance simple chemical equations (e.g., \(2H_2 + O_2 \rightarrow 2H_2O\): synthesis, decomposition, single replacement), given formulae, word equations, or descriptions of experiments. Then use molecular models to ensure they understand that atoms are not lost or gained in a chemical reaction. Continue by asking students to write and balance chemical reactions that are more complex (e.g., \(CH_4 + O_2 \rightarrow CO_2 + 2H_2O\): double replacement, neutralization, combustion).

ASSESSMENT STRATEGIES

- Ask students to write up the lab, using a prescribed format such as the one provided in the Lab Report: Performance Task Definition provided at the end of the Classroom Model for this grade. Collect students’ completed reports and assess for thoroughness and accuracy according the criteria provided in the outline. (You may also wish to use the scoring rubric provided at the end of the Classroom Model for this grade.)
- Have students use previous examples to create a worksheet of five chemical reactions that have appropriate reactants and products, with the correct solution. Other students can use and critique their worksheet based on criteria such as the following:
  - Are the formulae written correctly (e.g., using the correct subscripts and Roman Numeral if necessary)?
  - Are the reactants and products probable?
  - Have the equations been balanced (e.g., using the lowest whole number coefficients)?
| • Have students classify different reactions into the following types: | • Ask students to use symbols to create analogies representing the reactants and products of each of the reaction types and present these in a poster. For example, they could use letters of the alphabet or pictures to represent element symbols or compounds. Criteria for assessment could include the following:
- Are symbols appropriate?
- Are all the reaction types illustrated?
- Are the reaction types correctly portrayed?
- Are the symbols creative?
- Are the same symbols used throughout?
See also the sample scoring rubric provided at the end of the Classroom Model for this grade. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- synthesis</td>
<td>- the reaction type they explored</td>
</tr>
<tr>
<td>- decomposition</td>
<td>- the procedure they followed</td>
</tr>
<tr>
<td>- single and double replacement</td>
<td>- the balanced equation for the reaction</td>
</tr>
<tr>
<td>- neutralization</td>
<td>- a practical example from general knowledge or research.</td>
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<tr>
<td>- combustion</td>
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<tr>
<td>• Facilitate student labs in which they are divided into six groups to investigate one of the six different reaction types:</td>
<td>• Use student presentations as an assessment instrument. Each group should present to the class for peer assessment on the accuracy and clarity of:</td>
</tr>
<tr>
<td>- synthesis</td>
<td>- the reaction type they explored</td>
</tr>
<tr>
<td>- decomposition</td>
<td>- the procedure they followed</td>
</tr>
<tr>
<td>- single replacement</td>
<td>- the balanced equation for the reaction</td>
</tr>
<tr>
<td>- double replacement</td>
<td>- a practical example from general knowledge or research.</td>
</tr>
<tr>
<td>- neutralization</td>
<td></td>
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<tr>
<td>- combustion.</td>
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<tr>
<td>• Have students perform an experiment or series of experiments looking at factors that control reaction rate: temperature, concentration, catalyst, and surface area. Experiments could include</td>
<td>• Have students complete a chart for their experiments depicting reaction rate, temperature, catalyst, concentration, surface area, and a conclusion. Assess students’ work looking for:</td>
</tr>
<tr>
<td>- temperature—an effervescent indigestion tablet reacting with water at different temperatures</td>
<td>- complete diagram of what happened in each experiment</td>
</tr>
<tr>
<td>- concentration—different concentrations of vinegar reacting with baking soda</td>
<td>- correct chemical formula and names throughout</td>
</tr>
<tr>
<td>- catalyst—the effect of MnO₂ on hydrogen peroxide</td>
<td>- extensive description of what happened in each experiment</td>
</tr>
<tr>
<td>- surface area—HCl reacting with chunks vs. powdered CaCO₃.</td>
<td>- conclusion as to which factor appeared to be the most significant, based on their experiment.</td>
</tr>
<tr>
<td>• As an extension, have students identify a real-world application of controlling reaction rates. For example, students can research expansive mixtures—propane and air</td>
<td>• Have students write a newspaper article about a fictitious event involving reaction rates. Look for evidence that students are able to apply what they have learned about controlling reaction rates (e.g., temperature, catalyst, concentration, surface area).</td>
</tr>
<tr>
<td>• automobile air bags</td>
<td></td>
</tr>
</tbody>
</table>
# Grade 10 Physical Science: Chemical Reactions and Radioactivity

**Prescribed Learning Outcomes**

It is expected that students will:

C5. explain radioactivity using modern atomic theory

**Suggested Achievement Indicators**

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define *isotope* in terms of atomic number and mass number, recognizing how these are communicated in standard atomic notation (e.g., Uranium-238: $^{238}_{92}U$)
- relate radioactive decay (e.g., alpha – $\alpha$, beta – $\beta$, gamma – $\gamma$) to changes in the nucleus
- relate the following subatomic particles to radioactive decay:
  - proton ($^1_1p$)
  - neutron ($^0_0n$)
  - electron ($^0_-e$)
  - alpha particle ($^4_2\alpha$) ($^4_2He$)
  - beta particle ($^0_-\beta$)
- explain half-life with reference to rates of radioactive decay
- compare fission and fusion
- complete and balance nuclear equations to illustrate radioactive decay, fission, and fusion

**Planning for Assessment**

- Review the three sub-atomic particles, asking which one determines the type of element observed. After examining the periodic table, they should be able to recognize that each element is identified by its atomic number, i.e., the number of protons in every atom of that element.
  
  Explain the definition of the term isotope. Then, using toothpicks and foam balls of different colours, have students construct models of atomic nuclei to represent various elements, using mass numbers for info (e.g., carbon-12, carbon-14, nitrogen-14, oxygen-16, sulphur-32, chlorine-35, chlorine-37, argon-40, potassium-39, potassium-40). After doing so, have them explain
  - how mass number is determined
  - how each element is distinguished
  - what causes some atoms of a particular element to be different than others of the same element.

**Assessment Strategies**

- Students should draw and label their models and correctly list the element, number of protons, number of neutrons, and mass number. Concluding statements should be made explaining
  - the relationship between number of protons and type of element
  - the distinction between an atom and an isotope

Check students’ models and concluding statements for accuracy.
• In teams, have students research the terms: isotope, fission, fusion, half-life, alpha, beta, and gamma decay. Their research should include a definition and examples of each. Each team should put together a summary that they can share with the class.

• Have students practise writing nuclear equations demonstrating the correct use of atomic number, mass number, number of neutrons, and standard atomic notation. Then have students correctly identify, and place into the appropriate grouping, examples of the different types of nuclear equations. They should write fission, fusion, alpha, beta and gamma decay equations. The written equations should use standard atomic notation.

• Have students use a model to explore the concept of half-life. Have them plot half-life data for an isotope on a graph.

• Ask teams to record their research and summary in their notebooks. When assessing student research, look for inclusion of - fission reactions in nuclear reactors - fusion reactions in nuclear bombs or the sun - alpha decay used in smoke detectors - gamma decay used in radiation therapy
When the teams present their summary to the class, check for accuracy of definitions and examples.

• Evaluate student writing using the vocabulary development matrix below for the five types of nuclear equations (italics indicates the student response).

<table>
<thead>
<tr>
<th>Type of nuclear equation</th>
<th>Beta decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>When a neutron is transformed into a proton and a high speed electron (beta particle) is emitted from the nucleus</td>
</tr>
<tr>
<td>Characteristics</td>
<td>The mass number of the resulting isotope does not change, but the atomic number increases by 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
<th>Non-example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{32}<em>{15}P \rightarrow ^{32}</em>{16}S + ^0_1\beta$</td>
<td>$^{226}<em>{88}Ra \rightarrow ^{222}</em>{86}Rn + ^4_2\alpha$</td>
</tr>
</tbody>
</table>

• Assess student half-life graphs for title, appropriate scale, labelled axes, and a smooth curve.
- Provide direct instruction on the correct use of terms including *atomic number*, *mass number*, *number of neutrons*, and *standard atomic notation*. Use models to demonstrate alpha, beta, and gamma decay. Use blue for neutrons and red for protons; roll several balls of neutrons and an approximately equal number of protons. Have the balls mixed evenly and clumped loosely together to form a nucleus. Then perform the following:
  - remove two blue neutron balls and two red proton balls together (a helium nucleus) to show alpha decay; students should be able to state that the mass number of the atom is reduced by four, and the atomic number reduced by two, forming a new elemental atom
  - remove a small piece of one blue neutron ball, representing an electron or beta decay; at the same time, replace that blue ball with a red proton ball, to indicate the neutron has now changed into a proton, which once again changes the atomic number to form a new elemental atom
  - explain that in the process of radioactive decay, some gamma ray energy is released, and is usually referred to as gamma decay

- Have students correctly identify, and place into the appropriate grouping, examples of the three types of radioactive decay: alpha, beta, and gamma. Assess students’ abilities to
  - explain their grouping rationale
  - use appropriate vocabulary for each types of radioactive decay (e.g., particle, decay, neutron, transform, protein, high-speed electron, nucleus)
  - accurately use standard atomic notation.

- Have students use a model to explore the concept of half-life. For example, have students place thumbtacks in a petri dish. Have students perform the following procedures:
  - shake the dish, and remove all thumbtacks pointing downward
  - in a table, record the number of tacks remaining in the dish after the first shake
  - repeat the process until all tacks are gone
  - plot a graph of the number of tacks vs. shakes and draw a smooth curve through most of the points
  - using the line drawn, determine how many shakes were required to go down to 50 tacks; this is the half-life of the decaying tacks.

- Students should prepare a formal report that includes the following:
  - a diagram of the apparatus
  - all data neatly organized and recorded
  - a properly titled and labelled graph with a smooth curve clearly showing exponential decay
  - a marker on the graph indicating the half-life of the tacks
  - a concluding statement on how this model explains half-life.
- Explain the concepts of nuclear fission and fusion. Use examples to explain the similarities and differences, such as:
  - the fission process in a CANDU reactor
  - the fission and fusion process in nuclear bombs
  - the fusion process in the interior of our sun
  - the appropriate equation for each.

- Have students use a chart or other graphic organizer to compare the processes of fission and fusion. Points of comparison in students charts should include the following:
  - what happens to the nucleus
  - energy produced
  - examples
  - appropriate equations.
GRADE 10 PHYSICAL SCIENCE: MOTION

Prescribed Learning Outcomes

It is expected that students will:
C6 explain the relationship of displacement and time interval to velocity for objects in uniform motion

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define displacement (change in position, \( \Delta x \)), time interval (\( \Delta t \)), and velocity (\( v \))
- analyse graphically the relationship between displacement and time interval for an object travelling in uniform motion
- use the formula \( v = \frac{\Delta x}{\Delta t} \) to calculate the average velocity (\( v_{av} \)), displacement (change in position, \( \Delta x \)), and time interval (\( \Delta t \)) for an object in uniform motion, given appropriate data
- design and conduct one or more experiments to determine the velocity of an object in uniform motion (e.g., using carts, balls, skateboards, bicycles, canoes in still water)

<table>
<thead>
<tr>
<th>PLANNING FOR ASSESSMENT</th>
<th>ASSESSMENT STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Describe a situation in which an athlete runs once around a 400m track. To distinguish between distance and displacement, ask students to identify the length of the path travelled and the difference between the athlete’s initial and final positions. Ask students: “under what circumstances can distance and displacement be the same size?” They should be able to recognize that this condition only exists when an object travels forward in a straight line. Explain to students that if an object displays this motion, and if it is travelling at a constant speed, then the object is said to be in uniform motion.</td>
<td>• Assess students on their ability to differentiate terms, using examples of objects that travel forward, then reverse direction. Students should be able to distinguish between situations where displacement and distance are different and situations where they are the same. Given a variety of examples (e.g. a ball falling, a plane taking off, a rocket deploying its thrusters in space and subsequently shutting them off, a child riding a merry-go-round), students should be able to classify each type as uniform or non-uniform motion.</td>
</tr>
</tbody>
</table>
| • Use a small remote-controlled motorized car (to steer straight). Lay out a 50 m measuring tape along a length of hallway, and have a student time (with a stopwatch on interval mode) each 5 meter segment of the 50 m trip. | • Have students record position and time data arising from the straight-line motion of the motorized car. Have them calculate the ratios for change in position vs. time interval for each 5m segment and present this as a table. Assess their work, looking for completeness, accuracy, and inclusion of sample calculations to establish the ratios. Ask students to plot a graph of position vs. time from the data collected. They should be able to use a ruler to draw a single straight line through most of the points and draw an appropriate conclusion. Assess their work, looking for the extent to which they - correctly plotted position vs. time on a graph - drew an appropriate conclusion (i.e., at
- Have students create a similar experiment of their own to demonstrate the relationship between displacement and time interval, using objects such as carts, balls, skateboards, bicycles, or canoes in still water.
- As an alternative, in a gymnasium or outside, set up a series of exercises that involve running, skateboarding, throwing a ball, etc. At each station, provide a tape measure and stopwatch. Have students sketch the apparatus and perform the necessary calculations to determine the average velocity in each case.
- Introduce the formula \( v_{av} = \frac{\Delta x}{\Delta t} \) to calculate velocity \( (v_{av}) \), displacement (change in position, \( \Delta x \)), and time interval (\( \Delta t \)) for an object in uniform motion. Give students a variety of problems to solve for various objects travelling at uniform motion.
- As an extension, have students calculate the slope of the graph line and discuss the significance of this value (it is the velocity of the small car). Using the formula \( y = mx + b \), they can write the formula representing the relationship between displacement and time.

- Students could prepare a formal lab report on the activity, to be assessed using the Lab Report: Performance Task Definition and the Scoring Rubric for Lab Report supplied at the end of the Classroom Model for this grade level.
- Students should prepare an informal lab write-up that includes a sketch of each apparatus used, an explanation of the exercise performed, along with their calculations to determine the average velocity for each exercise.

- The correct answers should be indicated and all work clearly shown outlining their methodology for each problem. Correct units should also be used.
- All work should be shown clearly on the graph, including slope calculations and the equation for the line.

- Students should prepare an informal lab write-up that includes a sketch of each apparatus used, an explanation of the exercise performed, along with their calculations to determine the average velocity for each exercise.
GRADE 10 PHYSICAL SCIENCE: MOTION

Prescribed Learning Outcomes

It is expected that students will:
C7 demonstrate the relationship between velocity, time interval, and acceleration

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define acceleration (positive, negative, and zero)
- give examples of positive, negative, and zero acceleration, including
  - falling objects
  - accelerating from rest
  - slowing down or stopping
  - uniform motion
- given initial velocity ($v_i$), final velocity ($v_f$), and the time interval ($\Delta t$), calculate acceleration using the formula $a = \frac{\Delta v}{\Delta t}$, where $\Delta v = v_f - v_i$ (e.g., for falling objects)

<table>
<thead>
<tr>
<th>PLANNING FOR ASSESSMENT</th>
<th>ASSESSMENT STRATEGIES</th>
</tr>
</thead>
</table>
| • Toss a ball into the air and catch it at about the same level. Ask students to describe its motion. They should recognize that as the ball rises, its velocity decreases until it stops for an instant, and subsequently increases its velocity, but in the opposite direction, as it falls back to its original position. Explain that any object that increases or decreases its speed is said to be undergoing acceleration. By choosing the initial forward direction as positive, that acceleration is positive if the object increases speed at a constant rate, and negative if the object slows down. Point out that acceleration remains negative as the object moves in the opposite (negative) direction. | • Provide students with various examples of objects accelerating and decelerating. They should analyze each example and describe each of the following quantities as positive or negative, along with an explanation why:
  - displacement
  - initial velocity, final velocity, and change in velocity
  - acceleration
  Students should also recognize that an object in uniform motion has zero acceleration. |
| • Introduce the formula, $a = \frac{\Delta v}{\Delta t}$, where $\Delta v = v_f - v_i$ (e.g., for falling objects). Give students a variety of problems to solve for various accelerating objects. | • The correct answers should be indicated and all work clearly shown outlining their methodology for each problem. Correct units should also be used. |
GRADE 10

KEY ELEMENTS: EARTH AND SPACE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have described the processes associated with energy transfer within the Earth's geosphere and atmosphere and will have examined processes and features associated with plate tectonics.

Energy Transfer in Natural Systems (11-14 hours)

Vocabulary
atmosphere, conduction, convection, Coriolis effect, El Niño, greenhouse gases, heat, kilopascals, kinetic molecular theory, La Niña, ozone layer, permafrost, prevailing winds, thermal energy, tornado

Knowledge

• heat and thermal energy
• conduction and convection
• energy absorption and radiation in the atmosphere
• differential heating and prevailing winds
• changes in air density
• measurement of air pressure
• human-created and natural influences on climate
• climate affects natural systems

Skills and Attitudes

• illustrate energy transfer
• use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
KEY ELEMENTS: EARTH AND SPACE SCIENCE

Plate Tectonics (9-11 hours)

Vocabulary
asthenosphere, continental drift theory, converging/diverging plates, earthquakes, epicentre, fault, hot spot, inner core, lithosphere, mantle, mantle convection, outer core, paleoglaciation, plate boundary, plate tectonic theory, primary waves, ridge push and slab pull, rift valley, secondary waves, spreading ridge, subduction zone, surface waves, tectonic plate, transform fault, trench, volcanic belt, volcanic island arc, volcanoes

Knowledge
• plate movement and associated features and processes
• diverging, converging, and transform plate boundaries
• deep-focus to shallow-focus earthquakes
• continental drift theory
• magnetic reversals

Skills and Attitudes
• illustrate plate movement
• identify tectonic mapping symbols
• use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias)
## Grade 10: Earth and Space Science: Energy Transfer in Natural Systems

### Prescribed Learning Outcomes

*It is expected that students will:*

| D1 | explain the characteristics and sources of thermal energy |

### Suggested Achievement Indicators

*The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:*

- Define *heat* and *thermal energy*
- Explain and illustrate how thermal energy is transferred through conduction, convection, and radiation, with reference to
  - kinetic molecular theory
  - practical examples (e.g., home heating, cooking methods, loss of body heat, insulation)
- Describe Earth’s energy sources including
  - residual thermal energy from Earth’s formation
  - energy from radioactive decay
  - solar energy (with reference to absorption and radiation in the atmosphere)

### Planning for Assessment

<table>
<thead>
<tr>
<th>Planning for Assessment</th>
<th>Assessment Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define <em>thermal energy</em> and explain the concept of energy transfer. Have students work in groups and brainstorm situations where thermal energy is transferred. Ask students to explain how the thermal energy is transferred.</td>
<td>In their journals, have students list and explain situations where thermal energy is transferred, including definitions and diagrams. Student explanations should include information on conduction, convection, and radiation, with accompanying diagrams.</td>
</tr>
<tr>
<td>Ask students to define <em>conduction</em>, <em>convection</em>, and <em>radiation</em>, providing assistance by using illustrations to demonstrate how thermal energy is transferred in each case.</td>
<td>Ask students to record in their journals the information regarding transfer of thermal energy. They should list how thermal energy is transferred to the Earth, from the Earth, and inside the Earth (e.g., from radioactive decay). Diagrams should be used in the explanation of how thermal energy is transferred in these processes. Use the Thermal Energy Transfer Scoring Guide included at the end of the Classroom Model for this grade to assess student work.</td>
</tr>
<tr>
<td>In a Think-Pair-Share activity, have students review how thermal energy is transferred. Then ask them to apply these ideas to determine how the Earth gains and loses thermal energy, using conduction, convection, and radiation.</td>
<td></td>
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</tbody>
</table>

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*Implementation Sept. 2008*
GRADE 10: EARTH AND SPACE SCIENCE: ENERGY TRANSFER IN NATURAL SYSTEMS

Prescribed Learning Outcomes

It is expected that students will:
D2 explain the effects of thermal energy transfer within the atmosphere

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define atmospheric pressure and explain how it is measured
- identify weather conditions that typically accompany areas of low and high pressure in the atmosphere
- describe how energy transfer influences atmospheric convection, atmospheric pressure, and prevailing winds (e.g., differential heating of land and water causes changes in air density and affects prevailing winds)

PLANNING FOR ASSESSMENT

- Working in groups, have students define force and pressure, listing the different types of forces. Ask them to form small groups, blow up a balloon, and answer the following questions:
  - Why is the air in the balloon “harder or firmer” than the air in the room?
  - Why do we blow up tires on a car or bicycle?
  - What happens when you go up a mountain or fly in an airplane? Why do your ears ‘pop’?
  - How do we measure air pressure? On what does air pressure depend?
- Review the history of the development of barometers using slides or other multimedia. Show students a barometer and explain how it works.
- Have student groups each construct a simple barometer using instructions readily available online or in various resource books. Ask groups to take the air pressure in the class for several days, recording in their journals the following information:
  - the time of day
  - the temperature outside
  - the weather conditions
  - the barometer reading (high or low)

ASSESSMENT STRATEGIES

- Have students record in their journals definitions and create diagrams of force and pressure, looking for indications that groups have answered the four questions and provided diagrams and explanations on air pressure.
- Students should prepare journal reports with daily entries for a one week period, recording all relevant information pertaining to the local weather conditions, as well as the relative barometric readings displayed on their “home made barometer.” At the end of the recording term, conclusions should be drawn relating atmospheric pressure to the changes in weather observed. Predictions of future weather conditions can also be made, based on hypothetical changes to barometer readings.
- Ask students to consider why forced-air furnaces are always built in the basement of homes and not in the attics. Then demonstrate convection to students using smoke paper and a glass box apparatus, where heat from a lit candle beneath one vent causes smoke to rise, while at the other vent, smoke is pulled downward into the container. Students can infer from this that as warm air rises, air pressure decreases above the candle, thereby drawing in cooler surrounding air.

- Have students write up the demonstration, which should include
  - a neat diagram of the apparatus with arrows indicating the proper direction of the circulating smoke
  - a clear explanation as to why the smoke rises at one vent and sinks at the other
  - a description of how air pressure changes inside the apparatus from differential heating
  - a concluding statement on how convection works in fluids

- Brainstorm with students what high and low air pressure means. Show students several weather maps and determine the kind of weather in high and low pressure areas.

- Provide students with a map with an imaginary area showing highs and lows. Each student must predict the weather for the spot marked “x” on the map and explain in several sentences using the correct vocabulary why the prediction is believed to be correct.

- Ask students the following questions:
  - What happens to air if the pavement in the parking lot is in the sun? Does air from somewhere else move into where the hot air was?
  - If air heats and rises, what kind of current do we have?
  - If air particles move faster, what happens to the air pressure?
  - Do winds occur?
  - Why does pavement get hotter than the ground or water?
  - Do these convection currents happen in certain areas more than others (i.e., water vs. land; night vs. day)?

- In groups, have students suggest answers to the questions asked. Look for them to refer to kinetic molecular theory taught previously. Students should also be assessed on their ability to
  - describe the more rapid upward movement of air above warm land during the day (relative to air above water)
  - describe and explain the breeze moving from ocean to land due to the relative differences in atmospheric pressure between water and land
  - explain how more rapid cooling of land at night allows faster convection above water at night, effectively reversing the process.

- Have students perform an experiment using 100 W lamps to simultaneously heat containers of water and soil. They should record temperatures at regular intervals during the heating process, then remove the lamps and continue to record data as the materials cool down. Graphs can be plotted to illustrate the differential heating and cooling rates of soil and water, and relate these results to the effects of heating on land and ocean.

- Formal reports should include diagrams, appropriate data tables, accurately plotted graphs that compare changes in temperature with time for both water and soil, and a concluding statement explaining differences in summer and winter temperatures between coastal and inland communities. This can be assessed using the Scoring Rubric for Lab Reports provided at the end of the Classroom Model for this grade.
GRADE 10: EARTH AND SPACE SCIENCE: ENERGY TRANSFER IN NATURAL SYSTEMS

<table>
<thead>
<tr>
<th>Prescribed Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is expected that students will:</td>
</tr>
<tr>
<td>D3 evalulate possible causes of climate change and its impact on natural systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suggested Achievement Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:</td>
</tr>
<tr>
<td>- describe how natural phenomena can affect climate (e.g., biosphere processes, volcanic eruptions, Coriolis effect, El Niño and La Niña)</td>
</tr>
<tr>
<td>- describe how climate can be influenced by human activities (e.g., greenhouse gases, depletion of ozone layer)</td>
</tr>
<tr>
<td>- describe how climate change affects natural systems (e.g., shrinking of the permafrost region, melting of ice shelves/caps/glaciers)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLANNING FOR ASSESSMENT</th>
<th>ASSESSMENT STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ask students to brainstorm human activities that influence climate change. Use videos or other multimedia to illustrate such activities.</td>
<td>• Introductory activity — no assessment required.</td>
</tr>
<tr>
<td>• Have students form small groups and assign each group one natural phenomenon that affects climate (e.g., volcanic eruptions, Coriolis effect, El Niño and La Niña) or one significant climate change problem that affects natural systems (e.g., shrinking of the permafrost region, melting of ice shelves/caps/glaciers). Then have students work with members of their “expert” group to read about and/or research their topic. Each student prepares a short presentation which she or he will then use to teach the topic to other groups (e.g., including a poster that contains important facts, information, and diagrams related to the study topic).</td>
<td>• Assess student presentations, looking for evidence of relevant facts and information related to their chosen natural phenomenon (e.g., volcanic eruptions: release of gases and/or ash; Coriolis effect: movement of hurricanes; El Niño: warming of water current and effects on upwelling). Consider using the Presentation Evaluation tool provided at the end of the Classroom Model for this grade to assess group work. • You may also want students to assess contributions to their group, using the Group Member Evaluation Guide provided at the end of the Classroom Model for this grade.</td>
</tr>
<tr>
<td>• Have students take on the role of an official in the Ministry of the Environment and prepare a research-based presentation to inform the public about the future danger to the province of a human activity that contributes to climate change (or, take on the role of a reporter and prepare an article for a newspaper).</td>
<td>• Assess student presentations, looking for evidence that they provide supporting evidence for their position, use relevant research in an appropriate way, and identify a range of effects of human activity on climate (e.g., use of CFCs, use of thermal electricity generation, use of internal combustion engines, deforestation).</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td><strong>• Have students research how global warming is affecting natural systems in the Arctic that impact the Inuit way of life.</strong></td>
<td><strong>• Assess students’ research work, considering the extent to which they have addressed issues such as</strong></td>
</tr>
<tr>
<td></td>
<td>- temperature changes</td>
</tr>
<tr>
<td></td>
<td>- ice formation</td>
</tr>
<tr>
<td></td>
<td>- nature of the evidence</td>
</tr>
<tr>
<td></td>
<td>- effects on hunting and gathering activities</td>
</tr>
</tbody>
</table>
GRADE 10: EARTH AND SPACE SCIENCE: PLATE TECTONICS

### Prescribed Learning Outcomes

It is expected that students will:

- D4 analyse the processes and features associated with plate tectonics

### Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- define plate tectonics, plate boundary, earthquake, trench, volcano, spreading ridge, subduction zone, hot spot
- relate tectonic plate movement to the composition of the following layers of the Earth, as determined by seismic waves (primary, secondary, and surface waves):
  - crust
  - lithosphere
  - asthenosphere
  - mantle
  - outer core
  - inner core
- describe tectonic plate boundaries, including
  - transform boundaries
  - divergent boundaries
  - convergent boundaries (oceanic-oceanic crust, oceanic-continental crust, and continental-continental crust)
- identify tectonic mapping symbols
- explain how plate movement produces the following features:
  - epicentres and shallow-focus to deep-focus earthquakes
  - volcanism at subduction zones (e.g., volcanic island arcs, volcanic belts) and at spreading ridges
  - mountain ranges and mid-ocean ridges
  - hot spot chains (e.g., Hawaiian Islands, Yellowstone)
- identify sources of heat within the Earth that produce mantle convection and hot spot activity (i.e., heat within the core and excess radioactivity within the mantle)
- explain how mantle convection and ridge push and slab pull are believed to contribute to plate motion

### Planning for Assessment

- Review the Earth's layers with students and ask students how they think the layers were identified. Explain seismology and the use of earthquake waves in identifying the layers of the Earth.
- Use an interactive website (such as Virtual Earthquake, http://www.sciencecourseware.org/VirtualEarthquake/) to demonstrate how the location of epicentres is determined using P and S seismic waves.
- Relate the placement of Earth's layers to density by pointing out that thinner, metal rich, oceanic crust is denser and sits lower on the mantle, creating

### Assessment Strategies

- Give groups of four students copies of earthquake epicentre; volcano location; sea floor age and topography/bathymetry (elevation) world maps and ask them to work as a group, compiling the information in order to explain plate tectonic theory, both evidence and resulting physical features. Use the Digital Library for Earth System Education (DLESE) search engine for background information and detailed lesson plans; an excellent example, including a computer slide show presentation with maps and thorough explanations is http://terra.rice.edu/plateboundary/tg.html. Assess students on their ability to
ocean basins which fill up with water, while continental crust sits higher on the mantle, even though it’s much thicker. Density increases towards the center of the planet.

- Show world map plots of earthquake and volcano data and introduce the concept of tectonic plates, identified by the data. (Many websites show successive plots of earthquake and volcano data on world maps, outlining with increasing clarity natural plate boundaries.)

- Introduce sea floor spreading and the development of plate tectonic theory. Point out that an increase in oceanic crust at a spreading plate boundary means that crust will have to converge elsewhere as a result. Ask what would happen if the Earth were expanding at the same rate that new crust was being formed.

- With reference to a specific subduction zone, examine cross-section of earthquake data for the area, showing shallow to deep earthquakes across a subduction zone.

- Discuss transform plate boundaries, explaining their prevalence on the ocean floor because of variation in divergent plate movement.

- Explain the three types of plate boundaries and the various crustal variations of each type (continental and oceanic crust), using both plan (map) view diagrams and cross section diagrams.

- Draw a horizontal cross-section location line across a tectonic world map, preferably through southern British Columbia, and with students’ input, draw a cross-section of tectonic plate boundaries for the area under the line. Label each tectonic plate, each plate boundary and all appropriate earthquake patterns and related sites of volcanic eruptions.

- Using a world map which includes earthquake epicentres and volcanoes or plate boundaries, look at various places and ask students to explain what type of tectonic activity would occur in each.

- Work effectively in small groups
- Summarize the information
- Explain how the maps all relate to plate tectonics theory

Use the students presentations as an opportunity to correct any misconceptions in their understanding.

- Have students produce a concept map and write explanations of all plate tectonic features shown. Encourage the use of simple diagrams for explanations. Use the following Plate Tectonics Concept Map Scoring Guide to assess student work.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagram and connecting words include all key aspects of plate tectonics (deep- and shallow-focus earthquake, tsunami, volcano, tectonic plate, plate boundary, mid-ocean ridge, trench, hot spot).</td>
<td>3</td>
</tr>
<tr>
<td>Diagram and connecting words include most key aspects of plate tectonics.</td>
<td>2</td>
</tr>
<tr>
<td>Diagram and connecting words include some key aspects of plate tectonics.</td>
<td>1</td>
</tr>
</tbody>
</table>

- Test students’ understanding of plate tectonics theory by handing out world plate boundary maps with cross section location lines on them. Asks students to complete the appropriate cross-sections, marking for accuracy and understanding. Cross section locations can be horizontal or vertical, but must chosen carefully so that the plate boundaries are clearly defined on the maps.
**CLASSROOM ASSESSMENT MODEL • Grade 10**

- As an extension, have students find the epicentre of an earthquake. Provide information on the arrival of p and s waves at various seismic stations. Using the difference in the arrival times of the p and s waves at one station, ask students to determine how far the earthquake would be from the station and indicate on a map where the epicentre could be located. Repeating this for two more stations, have students use triangulation to locate the epicentre. A chart giving the distances from the epicentre relative to the difference in arrival times at the stations, provides further information about the earthquake. This can be done on the Virtual Earthquake (or other similar) websites. http://www.sciencecourseware.org/VirtualEarthquake/

- Describe the processes and features associated with the creation of Japan. Have students make notes, including a cross-section diagram of the formation of these islands. Next, explain that there is no subduction zone associate with the creation of the Hawaiian Islands. Brainstorm ideas as to how these islands might have formed, providing clues as needed, such as
  - the islands get progressively older, further from the big island of Hawaii
  - only the big island has any currently active volcanism
  - the remaining islands are being worn down by the ocean
  - there are zones of excess radioactivity in the mantle, creating hot spots of magma creation

  Students should draw a cross-section of how they think the Hawaiian Islands are related to plate tectonic activity, using textbooks or other appropriate resources.

- Demonstrate convection. Place a large (wide) beaker of cold heavy syrup or molasses (put in the freezer until very cold but not frozen) on a tripod, without a gauze pad in place to ensure localized heating. Place two small, thin pieces of cardboard on top of the cold syrup. Heat the beaker, using a low blue flame at the center of the base of the beaker. The syrup above the flame will slowly change colour

- Ask students to prepare journal entries on their earthquake observations. Provide copies of the Lab Reports Performance Task Definition, and assess their work using the Lab Report Scoring Rubric. Both of these items are provided at the end of the Classroom Model for this grade.

- Have students prepare a short report illustrating and comparing subduction zone eruptions and hot spot eruptions (e.g., Yellowstone Park in the U.S.A.). These reports could be assessed for the inclusion of
  - neat and accurate cross-section diagrams of each type of eruption process
  - arrows to indicate appropriate plate motion
  - labels for the diagrams

- Give students a list of major mountain ranges, earthquake epicentres, and significant volcanoes. In addition, supply a legend showing conventional symbols for tectonic mapping and a base map showing latitude and longitude. Have students identify the location of each item from the list on a world map, using appropriate symbols. They can also be asked to show the location of rifts, trenches, and divergent
and viscosity as it heats up. After several minutes, the cardboard will be driven apart by convection currents within the syrup.

- Review convection currents. Explain to students that plate movement is caused by convection currents in the mantle. These are thought to result from thermal energy from the core heating the mantle.

- Have students watch videos or other multimedia presentations of the phenomena associated with plate movement.

<table>
<thead>
<tr>
<th>boundaries. Assess</th>
</tr>
</thead>
<tbody>
<tr>
<td>- the accuracy of their locating work</td>
</tr>
<tr>
<td>- the extent to which students are able to correlate features with plate boundaries and use the symbols appropriately</td>
</tr>
</tbody>
</table>

- Ask students to identify the geological hazards, related to plate tectonics, which could occur in various places around the world. Where would travellers be most likely or least likely to experience these hazards? Assess students on their ability to conduct a group discussion.
GRADE 10: EARTH AND SPACE SCIENCE: PLATE TECTONICS

Prescribed Learning Outcomes

It is expected that students will:

D5 demonstrate knowledge of evidence that supports plate tectonic theory

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for the Prescribed Learning Outcome above. Students who have fully met the Prescribed Learning Outcome are able to:

- describe evidence for continental drift theory (e.g., fossil evidence, mountain belts, paleoglacialation)
- relate the following to plate tectonic theory:
  - the world distribution of volcanoes, earthquakes, mountain belts, trenches, mid-ocean ridges, and rift valleys
  - hot spot and subduction zone eruptions
  - magnetic reversals and age of rocks relative to spreading ridges

<table>
<thead>
<tr>
<th>Planning for Assessment</th>
<th>Assessment Strategies</th>
</tr>
</thead>
</table>
| • Provide students with a handout showing an outline of each of the major continents with the following markings
  - “matching” mountain chains
  - similar fossils
  - similar glacial evidence
  Explain that Alfred Wegener, who first proposed the idea of a super continent, noted specifically the jigsaw puzzle fit of the continents on either side of the Atlantic Ocean. Suggest that students start with the continents which border the Atlantic ocean. Once satisfied with their matching, students are to paste their rearranged continents onto the blank sheet under the title, “Pangea.” They should include a brief explanation of how they arrived at their result (rationale). | • Students are to cut out each continent, place them on another blank sheet of paper, and attempt to fit them together like a jigsaw puzzle to create a single “super continent.”
• Given that students are working on the basis of limited information, allow some latitude for divergent results. Assess students’ results by considering how well they
  - construct a reasonable fit
  - provide reasonable explanations for their continent-matching decisions |
| • Review Alfred Wegener’s work, given the knowledge available to him. Emphasize the lack of seismic data and lack of understanding of the ocean floor in his day.
• Discuss the importance of technology to our understanding of plate tectonics. Review the dates of key discoveries. | • Ask students to a draw simple time line including
  - Alfred Wegener’s presentation of his Theory of Continental Drift
  - the first mapping of the Atlantic sea floor
  - the proposal of the concept of sea-floor spreading
  - the development of Plate Tectonics Theory
  Assess for accuracy and completeness. |
| • As an extension, introduce current topics in geology, developed since Plate Tectonics Theory was introduced (e.g., accreted terranes, mapping heat within the Earth, and computer modelling of convection currents within the Earth). | • Ask students to write a letter to Alfred Wegener, telling him of the developments in technology and our current understanding of plate tectonics. Assess on accuracy and thoroughness. The letter should be a review of Plate Tectonics Theory and concepts. |
As an extension, ask students to research a current area of study in geology related to plate tectonics, such as the accretion of terranes, or modelling of convection currents within the mantle. Assess:
- the appropriateness of their choice
- the accuracy of their findings
- the extent to which they present information in their own words (an indication that they have assimilated explanations)
# LAB REPORT: PERFORMANCE TASK DEFINITION

<table>
<thead>
<tr>
<th>Name</th>
<th>Block</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

[ACTIVITY NAME]

**Purpose:** something that one sets out for oneself as an objective, the aim of the experiment; may be stated as a question

**Materials:** list of things you used in the experiment

**Procedure:**

1. Some experiments will just require you to list the textbook – name, page number and procedure numbers.
2. Other experiments will require you to enter the complete procedure, listing the steps to follow in conducting the experiment.

**Observations:** These would come in the same order as the procedures. Try to answer the following question: What was done for each procedure? What was seen/heard/feet/smelled/when you did the procedure? For example:

   a) Measurements of (length/mass/volume) were taken and recorded.
      The (mass/length/volume) of _____ was _______.
   
   b) Tables are drawn with a ruler and include all data. Correct symbols for units are used. The table is completed in pencil. A title for the table is included.

   c) Observed objects were drawn.

   d) Equipment used and its set up were diagrammed.

   e) It was observed that:
      the object was seen to ___________
      the object sounded like ___________
      the object felt like _________
      the object smelled like _________ (use caution when smelling)
      (Note: Most of the above would not be used for any one procedure)

**Questions:** At the end of each experiment you will find a question set that may be assigned. You must answer these in this section.

**Conclusions:** Try to answer some of the following questions for each experiment:

1. Name and describe any new terms and procedures you may have learned. (Did you do what you said you wanted to in the purpose?)
2. What other instruments (apparatus) might one have used in this experiment?
3. How accurate do you think your results are? Explain.
4. Have you learned a new skill, for example: Could what you learned help you predict something?
5. Try to generalize: Would this procedure work for other materials? If so, what?
6. How could you use what you learned in your daily life? Has this experiment changed your attitude about something?
7. Does what you learned have any value to you? (other than, “because I have to remember it for the test”)
8. How do you interpret your observations?
9. What are the connections and relationships that you have learned (more) about?

**Remember:** not all of the above can be answered for every experiment; but # 8 is always answered.
# Scoring Rubric for Lab Report

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Beginning (1)</th>
<th>Developing (2)</th>
<th>Accomplished (3)</th>
<th>Exemplary (4)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose is not written.</td>
<td>Purpose is written but the desired relationship is not stated.</td>
<td>Purpose is stated identifying the relationship to be determined.</td>
<td>Purpose is stated, clearly identifying the relationship to be determined and written in 3rd person passive.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Beginning (1)</th>
<th>Developing (2)</th>
<th>Accomplished (3)</th>
<th>Exemplary (4)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure is not written.</td>
<td>Procedure is written but the processes to be followed are not clear.</td>
<td>Procedure is written and the processes to be followed are easy to follow.</td>
<td>Procedure is written. The processes to be used are easy to follow and include other options to pursue.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations, Data and Diagrams</th>
<th>Beginning (1)</th>
<th>Developing (2)</th>
<th>Accomplished (3)</th>
<th>Exemplary (4)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations, data and diagrams are not included.</td>
<td>Observations, data and diagrams are included but are incomplete and/or messy.</td>
<td>Observations, data, and diagrams are included and are complete and neat.</td>
<td>Observations, data, and diagrams are included and are complete and neat. A pencil and ruler have been used when required.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions and Answers</th>
<th>Beginning (1)</th>
<th>Developing (2)</th>
<th>Accomplished (3)</th>
<th>Exemplary (4)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions and answers are not included.</td>
<td>Questions and answers are included but are incomplete.</td>
<td>Questions and answers are included and are mostly complete.</td>
<td>Questions and answers are included and are complete.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conclusion</th>
<th>Beginning (1)</th>
<th>Developing (2)</th>
<th>Accomplished (3)</th>
<th>Exemplary (4)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conclusion is not included.</td>
<td>Conclusion is included but is incomplete or has personal opinions such as “It smelled yucky” or “I liked this lab.”</td>
<td>Conclusion is included and is complete in 3rd person passive.</td>
<td>Conclusion is included. It is complete, written in 3rd person passive, and includes suggestions for future experiments.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Score =**
# Classroom Assessment Model • Grade 10

## Assessment Instrument
### Storyboard for Covalent and Ionic Compound Formation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title and written captions</strong></td>
<td>clear, but not eye-catching</td>
<td>clear and eye-catching</td>
<td>stands out, attracting attention; uses symbolism or humour</td>
</tr>
<tr>
<td>Bonding is shown in steps</td>
<td>steps are present but confusing or incomplete</td>
<td>steps show logical progression</td>
<td>steps show a thorough understanding of the subject</td>
</tr>
<tr>
<td>Bohr diagrams correctly shown</td>
<td>Bohr diagrams are incomplete missing $p^+$ and $n^0$</td>
<td>Bohr diagrams are complete with $p^+$, $n^0$ and $e^-$</td>
<td>Bohr diagrams are complete &amp; show understanding of the concepts</td>
</tr>
<tr>
<td>Creativity</td>
<td>colour, but ideas used to extend the content don’t relate well to bonding.</td>
<td>colour coding for the components or steps is clear and will help with memory</td>
<td>the use of colour is effective in making the connections memorable</td>
</tr>
</tbody>
</table>

104 • Science Grade 10

Implementation: Sept. 2008
## ASSESSMENT INSTRUMENT
### SLIDE PRESENTATION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Research credited and notes provided</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no bibliography or notes given</td>
<td>some references included and notes</td>
<td>all references given, sketchy notes</td>
<td>all references given, and notes show clear understanding</td>
</tr>
<tr>
<td><strong>Detail and depth of knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>some details of the compound provided</td>
<td>either too much or too little detail</td>
<td>depth of content is appropriate for the audience</td>
<td>appropriate depth, plus interesting points are made in the presentation</td>
</tr>
<tr>
<td><strong>Organization of presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ideas presented in no particular order</td>
<td>most ideas flow from one to another</td>
<td>ideas are presented logically</td>
<td>presentation has a flow that leads the audience to a thorough understanding</td>
</tr>
<tr>
<td><strong>Visual impact of presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>few images provided, and captions are hard to follow</td>
<td>images and captions are related and easy to see</td>
<td>each slide captures attention of audience</td>
<td>slides are visually attractive and have sound or action</td>
</tr>
<tr>
<td><strong>Creativity in presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>little imagination throughout the presentation</td>
<td>ideas used to explain the concepts don’t relate to the topic chosen</td>
<td>examples, analogies, or extensions relate to the topic</td>
<td>examples, analogies, or extensions make the topic memorable</td>
</tr>
</tbody>
</table>
# Assessment Instrument

## Poster

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• most information missing, incomplete, or incorrect</td>
<td>• some details missing</td>
<td>• all the information is provided</td>
<td>• information presented so it is memorable</td>
</tr>
<tr>
<td>• ideas presented in no particular order</td>
<td>• most ideas flow from one to another</td>
<td>• ideas are presented logically</td>
<td>• presentation leads the audience to a thorough understanding</td>
</tr>
<tr>
<td>• no use of colour</td>
<td>• poster has images, colour and some explanations</td>
<td>• images and explanations are related and easy to see</td>
<td>• poster captures attention of audience</td>
</tr>
</tbody>
</table>


# Presentation Evaluation

**Topics:** 

**Presenters:** 

5 = Exceeds Expectations, 4 = Fully Meets Expectations, 3 = Adequately Meets Expectations, 2 = Minimum Expectations Not Met, 1 = Not Yet Within Expectations

<table>
<thead>
<tr>
<th>Presentation Criteria</th>
<th>Teacher Assessment</th>
<th>Teacher Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong> — Presented on time and the process and sequence of the presentation was clear.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge</strong> — Understood the topic. Insightful connections made. High quality, relevant information included.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emphasis</strong> — Voice inflection, pauses, and repetition were used appropriately to hold the attention of the audience.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pace</strong> — Speed of delivery allowed for understanding and included pauses for clarification and audience note-taking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overview</strong> — Content and background of topic, outline of the presentation, and important people, terms, events introduced.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Visuals</strong> — Overheads or other visuals used to introduce new names, terms, and events to the audience.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong> — Major points were reviewed at the end of the presentation or at appropriate breaks in the topic.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quiz Questions</strong> — Prepared using appropriate starter prompts and questions were appropriate to the topic.</td>
<td></td>
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</table>

**TOTAL:** 

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>A = 35 - 40</th>
<th>B+ = 32 - 34</th>
<th>B = 29 - 31</th>
<th>C+ = 27 - 28</th>
<th>C = 24 - 26</th>
<th>C- = 20 - 23</th>
<th>I = 0 - 19</th>
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</table>
## THERMAL ENERGY TRANSFER SCORING GUIDE

<table>
<thead>
<tr>
<th>Mark</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Diagram and explanation includes all key aspects of thermal energy transfer including arrows showing thermal energy flow direction and accurate definitions.</td>
</tr>
<tr>
<td>2</td>
<td>Diagram and explanation includes most key aspects of thermal energy transfer including arrows showing thermal energy flow direction and accurate definitions.</td>
</tr>
<tr>
<td>1</td>
<td>Diagram and explanation includes a few key aspects of thermal energy transfer including arrows showing thermal energy flow direction and accurate definitions.</td>
</tr>
<tr>
<td>0</td>
<td>Diagram and explanation includes no key aspects of thermal energy transfer including arrows showing thermal energy flow direction and accurate definitions.</td>
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</table>
GROUP MEMBER EVALUATION GUIDE

(Each group member should complete this form individually)

Your Name: ______________________

Group Members: ____________________________________

Duties I specifically performed during the course of the assignment:

_________________________________________________________________________________________________
_________________________________________________________________________________________________

My own personal contribution amounted to _____ % of the total group preparation.

Strengths/difficulties my group experienced were:

____________________________________________________________________________________

Things my group could have done better are:

______________________________________________________________________________________

5 = Exceeds Expectations, 4 = Fully Meets Expectations, 3 = Adequately Meets Expectations, 2 = Minimum Expectations Not Met, 1 = Not Yet Within Expectations

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Group Member Names (include your own)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperation</td>
<td>Willing to work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Listened to group views</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Followed instructions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asked for help if needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Included all members</td>
<td></td>
</tr>
<tr>
<td>Leadership</td>
<td>An organizer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-starter (showed initiative)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contributed good ideas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active and energetic worker</td>
<td></td>
</tr>
<tr>
<td>Contribution</td>
<td>Dependable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attended meetings and classes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prepared their share</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finished work on time</td>
<td></td>
</tr>
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</table>
What Are the Criteria Used to Evaluate Learning Resources?

The Ministry of Education facilitates the evaluation of learning resources that support BC curriculum, and that will be used by teachers and/or students for instructional and assessment purposes. Evaluation criteria focus on content, instructional design, technical considerations, and social considerations.

Additional information concerning the review and selection of learning resources is available from the ministry publication, Evaluating, Selecting and Managing Learning Resources: A Guide (Revised 2002)

www.bced.gov.bc.ca/irp/resdocs/esm_guide.pdf

What Funding is Available for Purchasing Learning Resources?

As part of the selection process, teachers should be aware of school and district funding policies and procedures to determine how much money is available for their needs. Funding for various purposes, including the purchase of learning resources, is provided to school districts. Learning resource selection should be viewed as an ongoing process that requires a determination of needs, as well as long-term planning to co-ordinate individual goals and local priorities.

What Kinds of Resources Are Found in a Grade Collection?

The Grade Collection charts list the recommended learning resources by media format, showing links to the curriculum organizers. Each chart is followed by an annotated bibliography. Teachers should check with suppliers for complete and up-to-date ordering information. Most suppliers maintain web sites that are easy to access.

This section contains general information on learning resources, and provides a link to the titles, descriptions, and ordering information for the recommended learning resources in the Science 8 to 10 Grade Collections.

What Are Recommended Learning Resources?

Recommended learning resources are resources that have undergone a provincial evaluation process using teacher evaluators and have Minister’s Order granting them provincial recommended status. These resources may include print, video, software and CD-ROMs, games and manipulatives, and other multimedia formats. They are generally materials suitable for student use, but may also include information aimed primarily at teachers.

Information about the recommended resources is organized in the format of a Grade Collection. A Grade Collection can be regarded as a “starter set” of basic resources to deliver the curriculum. In many cases, the Grade Collection provides a choice of more than one resource to support curriculum organizers, enabling teachers to select resources that best suit different teaching and learning styles. Teachers may also wish to supplement Grade Collection resources with locally approved materials.

How Can Teachers Choose Learning Resources to Meet Their Classroom Needs?

Teachers must use either
• provincially recommended resources OR
• resources that have been evaluated through a local, board-approved process

Prior to selecting and purchasing new learning resources, an inventory of resources that are already available should be established through consultation with the school and district resource centres. The ministry also works with school districts to negotiate cost-effective access to various learning resources.
SCIENCE 8 TO 10 GRADE COLLECTIONS

The Grade Collections for Science 8 to 10 include newly recommended learning resources as well as relevant resources previously recommended for prior versions of the Science 8 to 10 curriculum. The ministry updates the Grade Collections on a regular basis as new resources are developed and evaluated.

Please check the following ministry web site for the most current list of recommended learning resources in the Grade Collections for each IRP:

www.bced.gov.bc.ca/irp_resources/lr/resource/gradcoll.htm
This glossary includes terms used in this Integrated Resource Package, defined specifically in relation to how they pertain to Science 8 to 10 topics. It is provided for clarity only, and is not intended to be an exhaustive list of terminology related to Science 8 to 10 topics.

**abiotic**
The non-living parts of the environment such as water, air, rocks.

**acid**
A compound containing hydrogen, which when it reacts with a compound containing a hydroxide ion, produces a salt and water.

**adaptive radiation**
The process by which members of a species adapt to a variety of habitats.

**Alpha radiation**
A type of radiation resulting from the emission of helium nuclei from the nuclei of atoms.

**alkali metal**
A chemical family of very reactive metals sharing similar chemical properties, containing the elements: lithium, sodium, rubidium, cesium, and francium.

**alkaline earth metal**
A chemical family of reactive metals sharing similar chemical properties, containing the elements: beryllium, magnesium, calcium, strontium, barium, and radium.

**amplitude**
The height of a wave crest or depth of a wave trough, measured from its middle, or equilibrium point.

**angle of incidence**
The angle of a ray of light approaching the boundary between two materials (such as from air into glass), measured between the incident ray and the normal.

**angle of refraction**
The angle of a ray of light emerging from the boundary between two materials (such as from air into glass), measured between the refracted ray and the normal.

**antibody**
A protein produced by B lymphocytes that complexes with invading antigens.

**antigen**
A foreign material that enters an organism.

**arête**
A sharp crested ridge that separates opposing alpine glaciers.

**asexual reproduction**
A form of reproduction in which only one parent is involved, and in which all the offspring are identical to each other and to the parent.

**atom**
The smallest particle of an element that can exist by itself.

**atomic mass**
The total mass of the protons, neutrons and electrons that make up an atom.

**atomic number**
The number of protons found in the nucleus of an atom.
bacteria
Small (1 – 100 μm) prokaryotic cells.

base
A compound containing hydroxide, which when it reacts with an ionic compound containing a positive hydrogen ion, produces a salt and water.

Beta particle
A high speed electron that is emitted by a radioactive nucleus in beta decay.

binary fission
A method of asexual reproduction in which the cell or organism splits into two equal parts.

bioaccumulation
The accumulation of a substance, such as a toxic chemical, in various tissues of a living organism.

biodegradation
The process by which a product can be broken down naturally, by biological agents, especially bacteria.

biome
A large area of the Earth that has characteristic climate, plants, animals and soil (e.g., Desert).

biotic
All of the organisms in the environment.

Bohr diagram
A diagram that shows the arrangement of an element’s subatomic particles.

Bohr Model
A model of the atom that describes the arrangement of an element’s subatomic particles: neutrons and protons in the nucleus, and electrons in electron shells.

boiling point
The temperature at which a liquid undergoes a phase change to become a gas.

bromothymol blue
A type of acid-base indicator that turns yellow when added to an acid.

budding
A method of asexual reproduction in which the offspring develops as a bud on the parent, until it drops off and becomes an independent organism.

cancer
A disease in which uncontrolled cell division results in the growth of malignant tumours in the body.

catalyst
A substance that speeds up a chemical reaction without being changed itself.

cell wall
A structure in plant cells (and some other types of cells) made of cellulose and other materials, which provides support for the plant cell.

centriole
An organelle found in pairs in animal cells, which organizes the spindle for chromosome division.

chloroplast
An organelle in plant cells that converts carbon dioxide and water into oxygen and glucose.
circulatory system
The system that distributes nutrients and oxygen to the cells as well as removing wastes and carbon dioxide from the cells.

climax community
The final stage of succession, where a stable group of two or more species is able to survive and reproduce indefinitely in the same habitat.

combustion
A type of chemical reaction in which oxygen is one of the reactants, and where heat is produced.

commensalism
A type of symbiotic relationship in which one organism benefits and the other is unaffected.

compound
A pure substance that is made up of two or more elements that have been chemically combined.

compression
The decrease in size (volume) of an object, caused by an increased external pressure acting on the object.

concentration
The amount of solute present in a specific volume of solution.

condensation
The change of state of a substance from gas form to liquid form, such as from steam to water.

conductivity
The ability or power of a substance to conduct or transmit heat or electricity.

Conservation of mass
A scientific law that states that in a chemical reaction, the total mass of the reactants always equals the total mass of the products.

continental drift theory
Theory put forth by A. Wegener in the early 20th century that proposed that continents moved around on the Earth’s surface and were at one time joined together.

continental shelf
A shallow, undersea plain stretching off the coast of a continent.

convection
A type of heat transfer in fluids (liquid or gas) where hot, less dense fluid rises and cold, denser fluid sinks. This causes heat to be distributed evenly throughout the fluid.

converging
A description of light rays coming to a focal point after reflecting off a converging mirror or refracting through a converging lens.

covalent bonding
The formation of a chemical bond through the sharing of one or more pairs of electrons.

covalent compound
A compound that is formed when non-metallic atoms share electrons to form a covalent bond.

crest
The highest point in a wave amplitude as measured from its middle or equilibrium point.
cytoplasm
The aqueous material and suspended organelles between the nucleus and cell membrane.

decomposer
An organism that feeds on waste and dead organisms.

decomposition
A type of chemical reaction in which a compound is broken down into two or more elements or simpler compounds.

density
The amount of mass contained in a given volume, usually measured in kg/cm³.

deposition
Phase change of a gas to a solid.

digestive system
The system that allows organisms to take in, break down and absorb nutrients.

diverging
A description of light rays spreading apart after reflecting off a diverging mirror or refracting through a diverging lens.

DNA
The genetic material of the cell, that is composed of four different types of nucleotides arranged in a chain.

double replacement
A type of chemical reaction during which elements in different compounds exchange places (e.g., AB + CD → AD + CB).

drumlin
An elongated (oval) hill formed by glacial movement.

ecological succession
The process of gradual change that occurs when organisms colonize a habitat, modify it, and are forced out by a new species better adapted to the now altered environment.

ecosystem
A network of interactions linking the biotic and abiotic things.

electromagnetic radiation
The total range or spectrum of energy in the form of waves that extend from the longest radio waves to the shortest gamma and cosmic rays.

embryonic development
The stages through which the developing offspring progresses from fertilization until about 8 to 10 weeks.

energy
The capacity for applying a force to effect motion. It is often thought of as the amount of movement or potential movement, usually measured in joules (J).

erosion
The movement of weathered materials.

erratic
Large rocks carried to a new location by a glacier and left behind after the glacier melts. The erratic differs from the rock types surrounding it.

eukaryotic cell
A cell with a nucleus and membrane bound organelles.

excretory system
The system that allows organisms to remove wastes.
expansion
The increase in size of an object, caused by a decreased external pressure acting on the object.

evaporation
The change of state of a substance from liquid form to gas form.

fertilization
The process in which a male and female gamete fuse to form a zygote.

fission
The process by which a large nucleus splits into two pieces of roughly equal mass, accompanied by the release of large amounts of energy.

food chain
A series of organisms, each of which relies for its food on the organism before it in the chain. (e.g., Sun → grass → rabbit → fox).

food pyramid
A diagram used to illustrate relationships between an organism’s population size and its place in a food chain.

food web
Food chains linked together within a particular ecosystem.

fragmentation
A type of asexual reproduction in which a large or small fragment of an organism can break off and develop into a new organism.

freezing point
The characteristic temperature at which a liquid solidifies.

focal point
The point at which converging light rays meet or from which light rays diverge.

force
A push or pull acting on an object, usually measured in newtons (N). For example, a magnet applies a pulling force on a piece of iron.

frequency
The number of repetitive motions, or oscillations, that occur in a given time, usually measured in cycles/second or hertz (Hz).

friction
A type of force that acts to oppose the motion of one object in contact with and relative to another object.

fusion
The joining of two small atomic nuclei to make a larger one. It is usually involves the release of a large amount of energy.

gamete
A reproductive cell of a sexually reproducing organism. Produced through the process of meiosis, the cell contains only half the number of chromosomes.

Gamma rays
The highest energy or frequency and shortest wavelength portion of the electromagnetic spectrum.

Gamma radiation
Electromagnetic radiation emitted from the nuclei of atoms.

gastric juice
A fluid with a pH of 2-3 produced by the walls of the stomach.
gas exchange
Carbon dioxide enters the blood and oxygen leaves the blood at the body cells. The process is reversed in the lungs.

gene
A segment of chromosome, which codes for a specific protein.

genetic engineering
The alteration of the genetic material of an organism through the addition or substitution of certain genes.

glaciation
The condition or result of being covered with a thick sheet of ice.

gravitation
A type of pulling force that acts between two or more objects, such as the earth and a baseball.

half-life
The amount of time required for half the nuclei in a sample of a radioactive isotope to decay.

halogen
A family of reactive non-metals sharing similar chemical properties, that contains the elements fluorine, chlorine, bromine, iodine, and astatine.

heavy metals
Metals such as mercury, lead and cadmium which have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of mammals can cause serious illness.

horn
A sharp peak formed by the movement of two or more opposing glaciers.

hot spot
Location of excess radioactivity, causing magma to rise from the mantle through the lithosphere to the surface.

hydraulic
A term that describes a device that is operated by the action of water or other liquid.

infrared
A type of electromagnetic radiation that, relative to light, has a longer wavelength and lower energy/frequency. It is also referred to as heat radiation.

immune system
The system that allows organisms to defend against disease.

inorganic
The chemistry of compounds that do not contain carbon.

ionic bonding
The bond that forms as a result of the attraction between positively and negatively charged ions.

ionic compound
A compound that forms as a result of positive and negative ions being held together by an ionic bond.

ion
An atom or group of atoms that is positively or negatively charged as a result of either gaining or losing one or more electrons.

isotopes
Atomic nuclei having the same number of protons but different numbers of neutrons.
keystone species
A particular type of organism that exerts great influence on an ecosystem relative to its abundance.

laws of electrical charge
Opposite charges attract each other,
similar charges repel each other,
charged objects attract neutral objects.

lens
A curved piece of transparent material that refracts light in such a way as to converge or diverge parallel light rays.

Lewis diagram
A representation of the element’s atom showing only the outer valence electrons.

light
The form of energy that can be detected by the eye.

litmus paper
A type of acid-base indicator that turns blue when added to a base and red when added to an acid.

magnetic
A type of force that acts on the elements iron, nickel or cobalt.

mantle convection
Thermal energy transfer in the mantle where hot, light magma rises and cold, dense lithospheric plate material sinks.

mass
The amount of matter that makes up an object, usually measured in kilograms (kg).

mass number
The total number of protons and neutrons found in the nucleus of an atom.

melting
The change of state of a substance from solid form to liquid form.

melting point
The temperature at which a substance changes from a solid to liquid state.

metabolism
The chemical reactions that take place in a living organism to provide energy, utilize materials and carry out vital processes.

mid-ocean ridge
Undersea mountain range that marks a divergent plate boundary; also called a spreading ridge.

mitochondrion
An organelle in eukaryotic cells that converts oxygen and glucose into cellular energy (ATP) carbon dioxide and water.

mirror
A device or surface that reflects light.

microwave
A type of electromagnetic radiation that has a longer wavelength and lower energy/frequency than infrared radiation.

molecule
A particle that consists of two or more atoms that are joined together.
multiple ion charge
Some metallic elements can form two different ionic charges depending on what type of chemical reaction they undergo (e.g., Fe2+ or Fe3+).

mutation
A change in the genetic material of the cell, which may have either a beneficial, harmful or neutral affect on the organism.

mutualism
A type of symbiotic relationship in which organisms interact for mutual benefit.

moraine
Material carried in, on, or under a glacier, which is deposited at the edges or end at the glacial flow.

natural selection
The process, proposed by Darwin, where the environment acts to select fit individuals.

nervous system
The system that allows the various parts of an organism communicate and work in concert.

neutralization
A chemical reaction in which an acid and a base combine to produce a salt and water.

noble gases
A family of non reactive element sharing similar chemical properties, that contains the elements: helium, neon, argon, krypton, xenon, radon.

normal
An imaginary line that is perpendicular to the boundary between two materials (such as air and glass) and intersects the point at which the incident ray reaches the boundary.

nucleus
A membrane-bound structure in eukaryotic cells that contains the genetic material and regulates the cell’s activities (i.e., growth and metabolism). The nucleus is also the control centre that contains the cell’s genetic material, which directs the production of proteins.

nutrient
A material that organisms need to live and grow.

ocean current
A large stream of moving water produced by gravity, wind friction, and water density.

opaque
A description of a material’s ability to prevent any light from passing through it.

organ
A group of tissues that perform a function.

organ system
A group of organs and tissues that perform a function to keep an organism alive.

organelles
A part of a eukaryotic cell that performs an essential life function.

organic
The chemistry of compounds that contain carbon.

organism
A living being that could be single-celled or multi-celled.

osmosis
The movement of water from a region of low solute concentration to a region of high solute concentration through a semi-permeable membrane.
GLOSSARY

paleoglaciation
A term describing past periods of extensive glaciation that covered most of the continents.

parasitism
A type of symbiotic relationship in which one organism benefits and the other is harmed.

pathogen
A bacteria, toxin, or other harmful material that can cause damage to an organism.

PCBs
Any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine, and are poisonous environmental pollutants which tend to accumulate in animal tissues.

pesticide
A substance used to control populations of plant or animal pests.

pH
A symbol denoting the concentration of hydrogen ions in a solution.

phagocytic white blood cells
Specialized white blood cells that act to remove foreign substances within the body (e.g., bacteria, dead tissue cells, and small mineral particles) and thus fight infection. They are called phagocytic because they engulf and absorb the foreign substance.

phenolphthalein
A type of acid-base indicator that turns pink when added to a base.

planet
A planet is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit. The eight planets in our solar system are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

plate boundary
Location where two plates meet and move relative to each other.

plate tectonic theory
Theory explaining that the Earth’s surface is made up of several lithospheric plates that move around relative to one another, sliding over the semi-fluid asthenosphere.

pneumatic
A term that describes a device that is operated by air or other gas.

polyatomic ion
A group of atoms that collectively carry a charge.

potassium
An element that is considered an nutrient, and needed to live and grow.

predation
A situation wherein one organism [the predator] kills and consumes another organism [the prey].

pressure
The amount of force acting over a given area on an object, usually measured in Newtons/cm².

proliferation
To grow or multiply by rapidly producing new tissues, cells, or offspring.

prokaryotic cell
A cell with no nucleus and membrane bound organelles, but with a nucleoid region and molecules that perform the functions of the organelles of eukaryotic cells.
radioactive decay
The process in which the nuclei of radioactive parent isotopes emit alpha, beta, or gamma radiation to form decay products.

radio waves
A type of electromagnetic radiation that has the longest wavelength and lowest energy/frequency compared to all other types.

reproductive system
The systems that allow organisms to produce offspring.

refraction
The bending or changing direction of a wave or light ray as it passes from one material into another.

ribosome
An organelle in eukaryotic cells responsible for the synthesis of proteins.

respiratory system
The system responsible for acquiring oxygen and removing carbon dioxide from the body.

ridge push and slab pull
A process that facilitates plate movement whereby dense, subducting plate material pulls the rest of the attached plate toward the subduction zone and down into the mantle, while the weight of the ridge being formed along a spreading mid-ocean ridge pushes the rest of (the same) tectonic plate away from the ridge, often towards a subduction zone.

salinity
The amount of salt in ocean water expressed in parts per thousand.

salt
A compound formed by the reaction of an acid and a base.

selectively permeable membrane
The type of membrane that surrounds cells. It controls what enters and leaves the cell.

sexual reproduction
The type of reproduction that requires the involvement of two parents, each of whom contributes a gamete. The fusion of the two gametes produces the zygote, the first cell of an offspring.

single replacement
A type of chemical reaction in which one element replaces another in a compound.

solidification
The change of state of a substance from liquid form to solid form, such as from water to ice.

spectrum
A range of frequencies for a given type of radiation. For example, the visible spectrum contains a range of several colours or frequencies of white light.

spreading ridge
Undersea mountain range that marks a divergent plate boundary; also called a mid-ocean ridge.

state
A phase of matter; may be solid, liquid or gas.

stem cells
The self-renewing cells found in the marrow of the long bones that give rise by differentiation and cell division to different types of cells.
striations
Parallel grooves in rocks or bedrock formed by glaciers scraping rocks over other rocks.

subatomic particle
A particle that is smaller than an atom. It is a term that usually refers to the proton, neutron, and electron that make up the atom.

subduction zone
Zone representing a convergent plate boundary, where one plate subducts beneath and is destroyed by the other overriding plate.

sublimation
The change of state of a substance from solid form to gas form or vice versa.

surface area
The extent of a two dimensional surface enclosed within a boundary.

symbiosis
A relationship in which two different organisms live in a close association.

synthesis
A type of chemical reaction in which two or more elements or compounds combine to form a single compound.

tectonic processes
The convergence, divergence and transform movement of the Earth’s lithospheric plates.

tertiary defence system
A component of the immune system that involves the creation of antibodies – proteins created by specialized white blood cells in response to foreign substances (antigens). By combining with the foreign substance (antigen), the antibodies may themselves neutralize it or alternatively flag it to bring it to the attention of other white blood cells that will attack and destroy it.

tissue
A group of structurally similar cells that perform a common function.

transform fault
A fracture zone between two offset segments of a mid-ocean ridge.

transform plate boundary
A type of plate boundary where two plates slide past each other horizontally in opposite directions relative to each other.

translucent
A description of a material’s ability to partially allow light to pass through it in such a way that it becomes diffused. Such materials do not allow objects to be seen distinctly.

transparent
A description of a material’s ability to allow light to pass through it freely. Objects can be clearly seen through such materials.

trench
A long narrow depression in the ocean floor that marks a convergent plate boundary and is part of a subduction zone.

trophic level
The number of energy transfers an organism is from the original solar energy entering the food chain.

trough
The lowest point in a wave amplitude as measured from its middle or equilibrium point.

turbidity
Cloudiness in water caused by suspended materials.
### Glossary

**ultraviolet**
A type of electromagnetic radiation that, relative to light, has a shorter wavelength and higher energy/frequency.

**vacuole**
A membrane bound sac that holds fluids or other materials.

**vegetative reproduction**
A method of asexual reproduction in plants, in which an offspring develops from a part of the plant other than the flower.

**virus**
A small (10 – 100nm) non-cellular particle that reproduces inside of other cells.

**viscosity**
A description of a fluid’s resistance to flow. For example, corn syrup has a higher viscosity than water.

**visible light**
A type of electromagnetic radiation that, relative to other forms, has an average wavelength and energy/frequency. It is composed of the following component colours: red, orange, yellow, green, blue and violet.

**volume**
The amount of space taken up by an object, usually measured in liters or cubic centimeters (cm³).

**wave**
A transfer of energy as a disturbance from one point in a material to another without causing any permanent displacement of the material.

**wavelength**
The distance between successive crests or troughs in a series of waves.

**weathering**
The breaking down of rock by physical, chemical or biological means.

**weight**
The amount of pulling force that gravity from earth or another celestial body exerts on an object.

**white blood cell**
Cells produced by red bone marrow and found in the blood or lymph. These cells fight pathogens in several different ways.

**wind action**
The processes or results of wind.

**X-rays**
A type of electromagnetic radiation that has a shorter wavelength and higher energy/frequency than ultraviolet.

**zygote**
The cell formed by the fusion of a male and female gamete, until it divides.