Please note: this Science Grade 9 document has been provided to assist school districts, schools, and teachers in preparing to deliver Science Grade 9 in 2007/2008, the first of year of prescribed implementation.

Feedback on an earlier draft of Science 8 to 10 was collected from June to December 2005. This feedback was provided by focussed review sessions as well as interested teachers, students, parents, school district staff, education partners, and stakeholders. This final draft of Science Grade 9 reflects revisions made as a result of this feedback.

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

SCIENCE GRADE 9

Integrated Resource Package 2006

BRITISH COLUMBIA
The Best Place on Earth

GBG 017

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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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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.

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)
- *Pan-Canadian Common Framework of Science Learning Outcomes* (1997), Council of Ministers of Education, Canada (http://cmec.ca/science/framework/)
- Science Curriculum Review Report (2001) http://www.bced.gov.bc.ca/branches/pser/whatsnew.htm#scrr
- Provincial science curricula
  - APEF (Atlantic Provinces Education Foundation)
  - Ontario
  - Manitoba
  - Alberta
- *Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education*, 3rd Edition (2000), Kendall, J. S. & Marzano, R.J. (http://www.mcrel.org/standards-benchmarks)
- *Atlas of Science Literacy* (2001), American Association for the Advancement of Science, Project 2061, National Science Teachers Association, Washington DC
- *Designs for Science Literacy* (2000), American Association for the Advancement of Science, Project 2061, National Science Teachers Association, Washington DC
- *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 an 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

Curriculum Organizer	Suggested Time Allocation
PROCESSES OF SCIENCE	integrated with other organizers
LIFE SCIENCE	20-25 hours
PHYSICAL SCIENCE	40-48 hours
EARTH AND SPACE SCIENCE	20-22 hours

Grade 9

Curriculum Organizer	Suggested Time Allocation
PROCESSES OF SCIENCE	integrated with other organizers
LIFE SCIENCE	20-25 hours
PHYSICAL SCIENCE	40-45 hours
EARTH AND SPACE SCIENCE	20-25 hours

Grade 10

Curriculum Organizer	Suggested Time Allocation
PROCESSES OF SCIENCE	integrated with other organizers
LIFE SCIENCE	20-25 hours
PHYSICAL SCIENCE	40-45 hours
EARTH AND SPACE SCIENCE	20-25 hours

SCIENCE K-10: AT A GLANCE

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

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.bced.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.

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

copyright law considers it "fair" to copy whole works, such as an article in a journal or a photograph, for purposes of research and private study, criticism, and review
- show videotaped television or radio programs to students in the classroom unless these are cleared for copyright for educational use (there are exceptions such as for news and news commentary taped within one year of broadcast that by law have record-keeping requirements—see the web site at the end of this section for more details)
- photocopy print music, workbooks, instructional materials, instruction manuals, teacher guides, and commercially available tests and examinations
- show videotapes at schools that are not cleared for public performance
- perform music or do performances of copyrighted material for entertainment (i.e., for purposes other than a specific educational objective)
- copy work from the Internet without an express message that the work can be copied

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.

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.

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 9

GRADE 9

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: Reproduction

It is expected that students will:

B1 explain the process of cell division
B1 relate the processes of cell division and emerging reproductive technologies to embryonic development
B3 compare sexual and asexual reproduction in terms of advantages and disadvantages

Physical Science: Atoms, Elements, and Compounds

It is expected that students will:

C1 use modern atomic theory to describe the structure and components of atoms and molecules
C2 use the periodic table to compare the characteristics and atomic structure of elements
C3 write and interpret chemical symbols of elements and formulae of ionic compounds
C4 describe changes in the properties of matter

Physical Science: Characteristics of Electricity

C5 explain the production, transfer, and interaction of static electrical charges in various materials
C6 explain how electric current results from separation of charge and the movement of electrons
C7 compare series and parallel circuits involving varying resistances, voltages, and currents
C8 relate electrical energy to power consumption

Earth and Space Science: Space Exploration

It is expected that students will:

D1 explain how a variety of technologies have advanced understanding of the universe and solar system
D2 describe the major components and characteristics of the universe and solar system
D3 describe traditional perspectives of a range of Aboriginal peoples in BC on the relationship between the Earth and celestial bodies
D4 explain astronomical phenomena with reference to the Earth/moon system
D5 analyse the implications of space travel

STUDENT ACHIEVEMENT

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 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.

For Ministry of Education reporting policy, refer to www.bced.gov.bc.ca/policy/policies/student_reporting.htm

Assessment *for* Learning	Assessment *as* Learning	Assessment *of* Learning
Formative assessment *ongoing in the classroom* • teacher assessment, student self-assessment, and/or student peer assessment • criterion-referenced—criteria based on prescribed learning outcomes identified in the provincial curriculum, reflecting performance in relation to a specific learning task • involves both teacher and student in a process of continual reflection and review about progress • teachers adjust their plans and engage in corrective teaching in response to formative assessment	Formative assessment *ongoing in the classroom* • self-assessment • provides students with information on their own achievement and prompts them to consider how they can continue to improve their learning • student-determined criteria based on previous learning and personal learning goals • students use assessment information to make adaptations to their learning process and to develop new understandings	Summative assessment *occurs at end of year or at key stages* • teacher assessment • may be either criterion-referenced (based on prescribed learning outcomes) or norm-referenced (comparing student achievement to that of others) • 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) • used to make judgments about students' performance in relation to provincial standards

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.

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.

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.

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/

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 9

GRADE 9

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, 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 electroscope, voltmeter, ammeter, Van de Graaff generator, Bunsen burner, 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 Bohr models
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- deduce relationships between variables 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 9 PROCESSES OF SCIENCE

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
A1 demonstrate safe procedures	❑ identify a variety of dangers in procedures (e.g., cuts from sharp objects; burns from heating devices; overloading a circuit; shocks from misuse of electrical equipment) ❑ identify appropriate equipment for an lab activity (e.g., Bunsen burner vs. hotplate) ❑ 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 tongs, waste receptacles to handle and dispose of chemicals) ❑ with teacher support, describe appropriate emergency response procedures (e.g., how to use a fire extinguisher/blanket, eye wash station, first aid for cuts, 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 - solar system model - star map or celestial sphere - simple chemical formulae - diagrams of a cell in stages of mitosis ❑ 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 bar graphs, line graphs, and tables, and diagrams (e.g., periodic table)

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
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., cell division—reproductive technologies; electrical energy—appliances; properties of matter—semiconductors) ❑ identify a variety of technologies and explain how they have advanced our understanding of science (e.g., microscopes for observing cell structure; instruments for observing astronomical phenomena)
A7 demonstrate competence in the use of technologies specific to investigative procedures and research	❑ select and carefully use appropriate technologies, including - microscope - balances and other measurement tools (e.g., thermometers, voltmeter, ammeter, Van de Graaff generator) - electrical circuitry devices (e.g., batteries, power supplies, switches, lamps, resistors) ❑ proficiently use the Internet as a research tool

GRADE 9

KEY ELEMENTS: LIFE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have developed understanding of the processes of cell division as they pertain to reproduction.

Vocabulary

binary fission, budding, cancer, cell cycle, chromosomes, DNA, embryonic development, fertilization, fragmentation, gametes, genes, meiosis, mitosis, nucleolus, sexual and asexual reproduction, stem cells, vegetative reproduction, zygote

Knowledge

- contents of the nucleus
- relationship between genes and proteins
- changes to cell membrane and nucleus during the cell cycle
- cancer
- sexual and asexual reproduction
- type(s) of reproduction
- adaptability of organisms
- zygote formation (fertilization)
- stem cells in embryonic development

Skills and Attitudes

- use microscopes
- apply the relationship between scientific principles and technology
- respect diverse opinions

GRADE 9 LIFE SCIENCE: REPRODUCTION

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
B1 explain the process of cell division	❑ identify the contents of the nucleus: chromosomes, DNA, genes, and nucleolus ❑ explain the significance of cell division, with reference to the basic relationship between genes and proteins (i.e., genes code for proteins) ❑ describe factors that may lead to changes in a cell's genetic information ❑ describe, in sequence, the stages and features of the cell cycle, including mitosis and cytokinesis ❑ describe cancer as abnormal cell division ❑ distinguish meiosis from mitosis in terms of outcomes (i.e., number of chromosomes and number of daughter cells)
B2 relate the processes of cell division and emerging reproductive technologies to embryonic development	❑ distinguish between male and female gametes ❑ describe the process by which a single zygote forms (fertilization) and develops ❑ describe and assess the impact of one or more emerging reproductive technologies (e.g., in vitro, cloning) ❑ explain the role of stem cells in embryonic development
B3 compare sexual and asexual reproduction in terms of advantages and disadvantages	❑ distinguish between sexual reproduction (e.g., human) and asexual reproduction (e.g., binary fission, budding, vegetative, fragmentation) in representative organisms ❑ relate sexual and asexual reproduction to adaptability of organisms

GRADE 9

KEY ELEMENTS: PHYSICAL SCIENCE

Estimated Time: 40-45 hours

By the end of this grade, students will have demonstrated understanding of how the nature of the atom relates to chemistry and electricity.

Atoms, Elements, and Compounds (18-20 hours)

Vocabulary

alkali metal, alkaline earth metal, atom, atomic mass, atomic number, Bohr model, conductivity, covalent compounds, density, electron, element, halogens, ionic compounds, mass, melting/boiling point, molecule, multiple ion charge, metal, metalloid, neutron, noble gases, non-metal, polyatomic ions, proton, state, subatomic particles, volume

Knowledge

- properties and states of matter
- physical and chemical change
- subatomic particles, properties, and location
- Bohr model
- atomic theory
- the structure and components of atoms and molecules
- metals, non-metals, and metalloids
- periodic table
- chemical symbols for elements
- chemical formulae for simple ionic compounds

Skills and Attitudes

- create models of atoms and ions
- draw Bohr models
- use the periodic table and common ion chart
- write chemical formulae and symbols
- name chemical compounds

KEY ELEMENTS: PHYSICAL SCIENCE

Characteristics of Electricity (22-25 hours)

Vocabulary

acetate, amperes, coulombs, current, electric force, electrons, energy, joules, kilowatt·hours, ohms, Ohm's Law, power, resistance, series and parallel circuits, static charge, Van de Graaff generator, voltage, volts

Knowledge

- static electrical charges
- relationships between charged objects
- electricity
- movement of charged particles
- electric current
- resistance and voltage
- Ohm's Law
- series and parallel circuits
- power and energy consumption

Skills and Attitudes

- measure voltage and current using appropriate equipment
- perform calculations
- draw circuit diagrams

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
C1 use modern atomic theory to describe the structure and components of atoms and molecules	❑ describe the development of atomic theory, including reference to Dalton, Rutherford, and Bohr ❑ distinguish between atoms and molecules ❑ identify the three subatomic particles, their properties, and their location within the atom
C2 use the periodic table to compare the characteristics and atomic structure of elements	❑ explain the organization of the periodic table of elements (e.g., atomic number, atomic mass, properties, families) ❑ distinguish between metals, non-metals, and metalloids ❑ use the periodic table to predict the properties of a family of elements (e.g., alkali, alkaline earth, halogens, and noble gases) ❑ draw a Bohr model of each atom up to atomic number 20 (including only protons and electrons)
C3 write and interpret chemical symbols of elements and formulae of ionic compounds	❑ differentiate between elements and compounds ❑ write chemical symbols for atoms and ions of elements ❑ differentiate between atoms and ions in terms of structure, using Bohr models ❑ write chemical formulae for ionic compounds, including those involving metals with non-metals, multivalent metals, and polyatomic ions ❑ name ionic compounds, given the chemical formula
C4 describe changes in the properties of matter	❑ identify physical properties of matter, including mass, volume, density, state at room temperature, colour, melting/boiling point, and conductivity ❑ differentiate between physical and chemical changes, citing observable evidence ❑ name the changes of state of matter, and describe how the kinetic molecular theory explains those changes

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
C5 explain the production, transfer, and interaction of static electrical charges in various materials	❑ explain, with illustrations, how static charges are separated because of transfer between various materials ❑ describe types of static electrical charge (positive, negative) and no charge (neutral) with reference to atomic theory ❑ describe how the electric force between two objects depends on types of charge, size of charge, and the distance between the two objects
C6 explain how electric current results from separation of charge and the movement of electrons	❑ distinguish between - potential and kinetic energy - static electricity and electric current - conventional current and electron flow ❑ relate the charge on electrons to electron flow in a circuit (i.e., from negative to positive) ❑ define *current* in terms of the amount of electric charge that passes a point in a given time interval
C7 compare series and parallel circuits involving varying resistances, voltages, and currents	❑ define resistance ❑ draw circuit diagrams using appropriate symbols that are properly placed ❑ conduct experiments to - measure voltage and current, using appropriate equipment and units (e.g., volts, amperes) - determine resistance, using current and voltage data ❑ perform calculations using Ohm's Law ❑ for a fixed supply voltage, differentiate qualitatively between series and parallel circuits in terms of - current (may change from resistor to resistor in parallel; remains the same in series) - voltage (may change from resistor to resistor in series; remains the same in parallel) - total resistance (increases with the number of resistors in series; decreases in parallel)
C8 relate electrical energy to power consumption	❑ define electrical energy and power ❑ calculate the following: - power—using voltage and current data - energy consumption—given the power rating of a device and duration of use

GRADE 9

KEY ELEMENTS: EARTH AND SPACE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have examined the formation, composition, and characteristics of the solar system, stars, and universe.

Vocabulary

asteroids, axis tilt, Big Bang, colonization, comets, constellations, Copernicus, galaxies, Kepler, moons, nebulae, planets, probes, Ptolemy, revolution, rotation, satellites, solar and lunar eclipses, spectroscopes, star clusters/types, Sun, telescopes, terraforming

Knowledge

- technologies advance understanding of the solar system, stars, and universe
- components of the universe and solar system
- significance of Earth's rotation, revolution, and axis tilt
- celestial sphere in relation to constellations and their location
- motion of constellations, planets, moons, sun, asteroids, and comets
- solar and lunar eclipses
- implications of space travel

Skills and Attitudes

- illustrate astronomical phenomena
- show respect for Aboriginal perspectives
- identify ethical considerations associated with space travel

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
D1 explain how a variety of technologies have advanced understanding of the universe and solar system	❑ identify and describe a range of instruments that are used in astronomy (e.g., telescopes, spectroscopes, satellites, probes, robotic devices) ❑ give examples of how astronomers use astronomical and space exploration technologies to advance understanding of the universe and solar system (e.g., using red shift to support the idea of an expanding universe, using parallax to measure distance)
D2 describe the major components and characteristics of the universe and solar system	❑ identify galaxies, star clusters/types, planets, constellations, nebulae according to their distinguishing characteristics ❑ relate mass to different stages in the life cycle of stars ❑ describe theories on the nature of the solar system (e.g., Ptolemy, Copernicus, Kepler) ❑ describe the formation of the solar system (e.g., condensing nebula) and its components (e.g., planets, moons, comets, asteroids, the Sun) and the formation of the universe (e.g., Big Bang) ❑ describe the processes that generate and events that distribute the energy of the Sun and other stars (e.g., nuclear fusion, solar flares and prominences, sun spots, solar wind)
D3 describe traditional perspectives of a range of Aboriginal peoples in BC on the relationship between the Earth and celestial bodies	❑ identify passages related to the relationship between the Earth and various celestial bodies within specific traditional stories of BC Aboriginal peoples ❑ respond to BC Aboriginal stories and presentations focusing on the nature of stars, the moon, planets, comets, or eclipses (e.g., by creating illustrations; by identifying similarities among stories or between stories and contemporary scientific understanding)
D4 explain astronomical phenomena with reference to the Earth/moon system	❑ describe the formation of the Earth's moon, with reference to supporting evidence ❑ describe the significance of Earth's rotation, revolution, and axis tilt (e.g., seasons, day/night) ❑ describe the celestial sphere in relation to constellations and their locations ❑ explain the apparent motion of constellations, planets, the Sun, the moon, asteroids, and comets ❑ explain and illustrate solar and lunar eclipses

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
D5 analyse the implications of space travel	❑ identify various possibilities and limitations associated with space travel (e.g., with reference to factors such as time, essential human needs, robots, budget choices, militarization of space) ❑ debate a range of ethical issues related to space travel (e.g., appropriateness of terraforming another planet, exposing humans to risks) ❑ research current ideas or initiatives for further space exploration (e.g., space elevator, colonization of other planets, search for extraterrestrial life)

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
- brainstorms, clusters, webs
- 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 web site: http://www.bced.gov.bc.ca/irp_resources/lr/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 9

GRADE 9: 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 9 Science.

Curriculum Organizers/ Suborganizers	Suggested Assessment Activities	Suggested Weight for Grading	Number of Outcomes	Number of Outcomes by Domain*			
				K	U&A	HMP	AFF
PROCESSES OF SCIENCE	• integrated throughout – assessed in relation to performance tasks associated with each of the other organizers	25%	7	1	4	1	1
LIFE SCIENCE	• demonstrating • summarizing • comparing • diagramming & illustrating • observing/reporting • role playing • problem solving • written test (e.g., lab report)	20%	3	0	2	1	0
PHYSICAL SCIENCE	• demonstrating • experimenting • diagramming & illustrating • observing/reporting • researching • problem solving • modelling (e.g., lab report)	35%	8	1	6	1	0
EARTH AND SPACE SCIENCE	• explaining • diagramming & illustrating • observing/reporting • researching • modelling (e.g., field study)	20%	5	2	2	1	0
TOTALS		100%	23	4	14	4	1

* 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 9 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, 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 electroscope, voltmeter, ammeter, Van de Graaff generator, Bunsen burner, 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 Bohr models
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- deduce relationships between variables 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 9 PROCESSES OF SCIENCE

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*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:*
A1 demonstrate safe procedures	❑ identify a variety of dangers in procedures (e.g., cuts from sharp objects; burns from heating devices; overloading a circuit; shocks from misuse of electrical equipment) ❑ identify appropriate equipment for an lab activity (e.g., Bunsen burner vs. hotplate) ❑ 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 tongs, waste receptacles to handle and dispose of chemicals) ❑ with teacher support, describe appropriate emergency response procedures (e.g., how to use a fire extinguisher/blanket, eye wash station, first aid for cuts, 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 - solar system model - star map or celestial sphere - simple chemical formulae - diagrams of a cell in stages of mitosis ❑ 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 bar graphs, line graphs, and tables, and diagrams (e.g., periodic table)

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
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., cell division—reproductive technologies; electrical energy—appliances; properties of matter—semiconductors) ❑ identify a variety of technologies and explain how they have advanced our understanding of science (e.g., microscopes for observing cell structure; instruments for observing astronomical phenomena)
A7 demonstrate competence in the use of technologies specific to investigative procedures and research	❑ select and carefully use appropriate technologies, including - microscope - balances and other measurement tools (e.g., thermometers, voltmeter, ammeter, Van de Graaff generator) - electrical circuitry devices (e.g., batteries, power supplies, switches, lamps, resistors) ❑ proficiently use the Internet as a research tool

GRADE 9

KEY ELEMENTS: LIFE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have developed understanding of the processes of cell division as they pertain to reproduction.

Vocabulary

binary fission, budding, cancer, cell cycle, chromosomes, DNA, embryonic development, fertilization, fragmentation, gametes, genes, meiosis, mitosis, nucleolus, sexual and asexual reproduction, stem cells, vegetative reproduction, zygote

Knowledge

- contents of the nucleus
- relationship between genes and proteins
- changes to cell membrane and nucleus during the cell cycle
- cancer
- sexual and asexual reproduction
- type(s) of reproduction
- adaptability of organisms
- zygote formation (fertilization)
- stem cells in embryonic development

Skills and Attitudes

- use microscopes
- apply the relationship between scientific principles and technology
- respect diverse opinions

GRADE 9: LIFE SCIENCE: REPRODUCTION

Prescribed Learning Outcomes

It is expected that students will:

B1 explain the process of cell division

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 the contents of the nucleus: chromosomes, DNA, genes, and nucleolus
- ❑ explain the significance of cell division, with reference to the basic relationship between genes and proteins (i.e., genes code for proteins)
- ❑ describe factors that may lead to changes in a cell's genetic information
- ❑ describe, in sequence, the stages and features of the cell cycle, including mitosis and cytokinesis
- ❑ describe cancer as abnormal cell division
- ❑ distinguish meiosis from mitosis in terms of outcomes (i.e., number of chromosomes and number of daughter cells)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Use direct instruction to identify and explain the role of the chromosomes, cell membrane, cytoplasm, and nucleus in the process of cell division. Review (from Grade 8) cell organelle structures, their functions, and the differences between the single plant and animal cell.	• no assessment necessary
• Use diagrams to illustrate the fundamental relationships among the nucleus, chromosomes, genes, ribosomes, and proteins. Extend the discussion by focussing on the effect of mutations on genetic information.	• Challenge students to create a presentation (e.g., written analogy, drama) to illustrate the relationships among the nucleus, chromosomes, genes, ribosomes, and proteins during normal cellular function and after a mutation has occurred. Assess students' work, looking for evidence that they - represent each component - show the relationships among each component - depict a valid analogy or representation - depict a valid result of a mutation
• Provide students with readings and other resource information about how cancer is related to cell division. Include a focus on concepts such as rapid and disorganized growth, invades other tissues, abnormal nucleus, and agents causing changes to genes.	• Have students write a "What Is Cancer?" booklet for an elementary student audience. Assess students' booklets for the extent to which they - identify potential contributing factors (e.g., lifestyle and environmental factors) - include information about how cancer relates to cell division - incorporate terminology such as benign, malignant, and metastasis - present the information in an age-appropriate manner

• Using microscopic slides (or if not available models, diagrams or videos), show students the sequence of stages and features in a cell cycle (mitotic cell division). Students could observe under the microscope structures that are included in the stages and describe the differences among the structures.	• Provide students with a series of diagrams illustrating the stages of mitosis and cytokinesis. Have students put the diagrams in the correct order and label and describe the changes that occur at each stage. Assess students' diagrams for accuracy and completeness. • Have students create a visual display using either charts, overheads, or electronic slide shows to illustrate mitotic cell division. Students' displays should outline the events of cell division, and describe the similarities and difference between plant and animal cells.
• Use direct instruction to identify and explain meiotic cell division—duplication of genetic material, division, second division. Continue the discussion by focussing on similarities and differences between meiotic and mitotic cell division, including number of cells, number of chromosomes in each daughter cell.	• Ask students to create a cartoon that displays the differences between mitosis and meiosis. Look for evidence that students are able to relate each to its biological significance (i.e., meiosis produces gametes for sexual reproduction, mitosis produces body cells).

GRADE 9: LIFE SCIENCE: REPRODUCTION

Prescribed Learning Outcomes

It is expected that students will:

B2 relate the processes of cell division and emerging reproductive technologies to embryonic development

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:

- ❑ distinguish between male and female gametes
- ❑ describe the process by which a single zygote forms (fertilization) and develops
- ❑ describe and assess the impact of one or more emerging reproductive technologies (e.g., in vitro, cloning)
- ❑ explain the role of stem cells in embryonic development

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Conduct a lab on gametes and embryonic development, looking at prepared slides of egg and sperm cells and the early stages of embryonic development.	• Have students prepare diagrams of the egg cell, sperm cell, and label provided diagrams of the different embryonic stages (including two, four, or eight blastomeres; blastula; early, mid, or late gastrula). Students should accompany diagrams with a report that answers the following: - Compare the size of the egg and sperm cells. Explain the difference in size. - How are the shapes of the cells related to their functions? - What happens to the sperm and egg cells after fertilization occurs? - In what ways might human cells and tissues be similar to those you observed?
• Conduct a class discussion about stem cells, their significance, and the various types of reproductive technologies (e.g., in vitro fertilization, cryonics, cloning).	• Have students select and analyse a selected article about reproductive technologies and stem cell research. Look for evidence that students are able to - identify the main points in the article - identify the point of view and any previous assumptions of the article's author - assess the currency of the article - relate the technologies to the scientific principles involved - relate the technologies to their own beliefs - identify how the technology has advanced our understanding of science

GRADE 9: LIFE SCIENCE: REPRODUCTION

Prescribed Learning Outcomes

It is expected that students will:

B3 compare sexual and asexual reproduction in terms of advantages and disadvantages

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:

- ❑ distinguish between sexual reproduction (e.g., human) and asexual reproduction (e.g., binary fission, budding, vegetative, fragmentation) in representative organisms
- ❑ relate sexual and asexual reproduction to adaptability of organisms

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Have students use a jigsaw (cooperative learning) approach to learn about the various types of asexual reproduction, including - fragmentation - budding - binary fission - vegetative Expert groups then share finds with the rest of the class. Discuss as a class, focussing on the characteristics of each type of asexual reproduction. Continue the discussion by comparing asexual reproduction to sexual reproduction. What are the similarities and differences? What are the advantages and outcomes of each?	• Display pictures of each type of asexual reproduction, and ask students to identify each (e.g., "Is this fragmentation? Why or why not?). Look for evidence that students are able to identify each type accurately and support their answers. • Have students prepare a contrast graphic organizer comparing sexual and asexual reproduction. Look for evidence that they are able to compare advantages and disadvantages including - number of offspring produced - genetic diversity of offspring
• Think-Pair-Share: have students identify situations in which one form of reproduction may be more advantageous than another. Have students research organisms that can reproduce both sexually and asexually (e.g., jellyfish, poplar tree) and present their findings.	• Student presentations should address the following questions: - What are the advantages of a jellyfish being able to use either method of reproduction? - Which method of reproduction would be the most advantageous for a single poplar tree growing in the middle of a field? Explain. - Which method of reproduction would be the most advantageous for a poplar tree growing in a dense forest? Explain. - Name other organisms that are capable of reproducing sexually and asexually, and comment on the environment in which they live.

GRADE 9

KEY ELEMENTS: PHYSICAL SCIENCE

Estimated Time: 40-45 hours

By the end of this grade, students will have demonstrated understanding of how the nature of the atom relates to chemistry and electricity.

Atoms, Elements, and Compounds (18-20 hours)

Vocabulary

alkali metal, alkaline earth metal, atom, atomic mass, atomic number, Bohr model, conductivity, covalent compounds, density, electron, element, halogens, ionic compounds, mass, melting/boiling point, molecule, multiple ion charge, metal, metalloid, neutron, noble gases, non-metal, polyatomic ions, proton, state, subatomic particles, volume

Knowledge

- properties and states of matter
- physical and chemical change
- subatomic particles, properties, and location
- Bohr model
- atomic theory
- the structure and components of atoms and molecules
- metals, non-metals, and metalloids
- periodic table
- chemical symbols for elements
- chemical formulae for simple ionic compounds

Skills and Attitudes

- create models of atoms and ions
- draw Bohr models
- use the periodic table and common ion chart
- write chemical formulae and symbols
- name chemical compounds

KEY ELEMENTS: PHYSICAL SCIENCE

Characteristics of Electricity (22-25 hours)

Vocabulary

acetate, amperes, coulombs, current, electric force, electrons, energy, joules, kilowatt·hours, ohms, Ohm's Law, power, resistance, series and parallel circuits, static charge, Van de Graaff generator, voltage, volts

Knowledge

- static electrical charges
- relationships between charged objects
- electricity
- movement of charged particles
- electric current
- resistance and voltage
- Ohm's Law
- series and parallel circuits
- power and energy consumption

Skills and Attitudes

- measure voltage and current using appropriate equipment
- perform calculations
- draw circuit diagrams

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

Prescribed Learning Outcomes

It is expected that students will:

C1 use modern atomic theory to describe the structure and components of atoms and molecules

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 the development of atomic theory, including reference to Dalton, Rutherford, and Bohr
- ❑ distinguish between atoms and molecules
- ❑ identify the three subatomic particles, their properties, and their location within the atom

PLANNING FOR ASSESSMENT

- Use an Anticipation Guide of five true and false questions to begin the study of atomic theory.

Anticipation Guide

- The ancient Greeks first proposed atoms. T/F
- An atom resembles a solid ball. T/F
- The first subatomic particle discovered was the electron. T/F
- Atoms of an element can vary. T/F
- Atoms contain equal numbers of positive and negative charges. T/F

- Present students with information on the development of atomic theory and the discovery of the three subatomic particles (protons, neutrons and electrons), including the contributions of Dalton, Rutherford, and Bohr.

ASSESSMENT STRATEGIES

- Have students construct a timeline on atomic theory. Look for evidence that students have
  - included the major contributions of these scientists
  - described how understanding of the components of the atom (protons, neutrons, and electrons) has developed over time

- Have each student construct a chart in his or her notebook containing information on the three subatomic particles. Evaluate student charts using the following template (italics indicates the student response).

	Charge	Location	Relative Mass	Symbol
Proton	+	*Nucleus*	*1*	*p*
Neutron	*0*	*Nucleus*	*1*	*n*
Electron	-	*Outside the nucleus*	*1/1800*	*e*

PLANNING FOR ASSESSMENT

- Using molecular models to represent atoms, have students combine these to represent molecules. As an example, use a black ball with four holes to represent a carbon atom and attach four yellow balls to represent hydrogen atoms, forming the compound methane. Other molecules could include water, hydrogen peroxide, ammonia, carbon dioxide, and methanol.

ASSESSMENT STRATEGIES

- Have students record (draw) the resulting molecules. An accurate drawing would show the correct number of atoms arranged with the correct number of attachments (bonds).
- Using the drawings of molecules above as examples, have students determine a definition of an atom and a molecule.

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

Prescribed Learning Outcomes

It is expected that students will:

C2 use the periodic table to compare the characteristics and atomic structure of elements

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 the organization of the periodic table of elements (e.g., atomic number, atomic mass, properties, families)
- ❑ distinguish between metals, non-metals, and metalloids
- ❑ use the periodic table to predict the properties of a family of elements (e.g., alkali, alkaline earth, halogens, and noble gases)
- ❑ draw a Bohr model of each atom up to atomic number 20 (including only protons and electrons)

<table>
<tr><th>PLANNING FOR ASSESSMENT</th><th>ASSESSMENT STRATEGIES</th></tr>
<tr><td>• Provide pairs of students with cards that list the names and physical/chemical properties of the first 20 elements. Ask students to arrange them in order from lowest atomic number to highest, and then attempt to arrange them in columns that have similar properties.</td><td>• Have students glue the cards onto a Periodic Table template and answer the following questions:
- What happens to the atomic mass from element 1 to 20?
- What are some similar properties for the elements in columns 1, 2, 7, and 8?
- What happens to the atomic radius of the elements across the second row?
- Is the trend the same across the third row?
- Why might atoms in a column have similar properties?</td></tr>
<tr><td>• Review the Bohr model of the atom and introduce the Bohr diagram. Instruct students to place the correct number of protons in the middle of the diagram, and place the electrons around this in the pattern 2, 8, 8, 18.</td><td>• Have students draw Bohr diagrams of the first 20 elements on the Periodic Table. Evaluate the correct placement of the protons and electrons.</td></tr>
<tr><td>• Have students determine from text or Internet material the families and properties of: Alkali Metals, Alkaline Earths, Halogens, and Noble Gases.</td><td>• Have students fill in the following chart, comparing the reactivity of the families and the number of electrons in the outermost shell of the Bohr diagram.
<table>
<tr><th></th><th>Properties - reactivity of members of the family</th><th>Number of electrons in the outermost shell</th></tr>
<tr><td>Alkali Metals</td><td></td><td></td></tr>
<tr><td>Alkaline Earths</td><td></td><td></td></tr>
<tr><td>Halogens</td><td></td><td></td></tr>
<tr><td>Noble Gases</td><td></td><td></td></tr>
<tr><td>CONCLUSION:</td><td></td><td></td></tr>
</table>
Evaluate the conclusion. Do students state that all families, except the Noble gases with the</td></tr>
</table>

	filled outer electron shell are reactive? Do they suggest that a filled outer shell imparts stability?
• Have students identify the regions on the Periodic Table that correspond to metals, metalloids, and non-metals.	• Provide students with a Periodic Table or template. Have students colour and label the regions that correspond to metals, metalloids, and non-metals. Check for accuracy.

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

Prescribed Learning Outcomes

It is expected that students will:

C3 write and interpret chemical symbols of elements and formulae of ionic compounds

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:

- ❑ differentiate between elements and compounds
- ❑ write chemical symbols for atoms and ions of elements
- ❑ differentiate between atoms and ions in terms of structure, using Bohr models
- ❑ write chemical formulae for ionic compounds, including those involving metals with non-metals, multivalent metals, and polyatomic ions
- ❑ name ionic compounds, given the chemical formula

PLANNING FOR ASSESSMENT

- With students working in pairs, provide a card with an element or a compound name and formula on it. Ask the pair to decide if it is an element or a compound AND if it is an atom or a molecule. Tell students you will ask them to justify their answers.
- After students have categorized their substances, list them on the O/H or board.

Substance	Element	Atom	Comp'd	Molecule
NaOH			x	x
O2	x			x
C	x	x		
etc				

- Discuss their choices. Provide a definition of *element* and *compound*, and see if they want to change any choices.

ASSESSMENT STRATEGIES

- Ask students to compare the terms *element* and *compound* AND *atom* and *molecule* in their notebooks.
- Provide students with exemplary comparisons and examples so they can self-evaluate and correct their work.

PLANNING FOR ASSESSMENT

- Brainstorm with students reasons that elements come together to form compounds (positive ions attract negative ions). Provide students with a Periodic Table that shows the ion charges on the elements and a Table of Common Ions. Then have students practise recognizing and writing atom and ion symbols. They should realize electrons are lost or gained.

ASSESSMENT STRATEGIES

- Have students complete an assessment activity such as the Ion Charge Chart provided at the end of the Classroom Model for this grade. Assess the extent to which students are able to accurately complete the chart.

PLANNING FOR ASSESSMENT

- Have students draw Bohr diagrams of ions (1 to 20): negative ions gain electrons to fill their outermost shell and positive ions lose electrons.

ASSESSMENT STRATEGIES

- Collect students' Bohr drawings, looking for evidence that they are able to
- correctly identify the number of protons and electrons in an ion
- predict the ion charge for an element based on their diagram

• Explain that ionic compounds form when a metal ion combines with a non-metal ion. When the two elements chemically combine, the ion charges are balanced. Practice with several examples. Models can be used to visually represent this relationship. • Have students practise writing chemical formulae for ionic compounds: - Monovalent metal with a non-metal - Multivalent metal with a non-metal - Either a monovalent or multivalent metal with a polyatomic ion	• Assign groups of students ten different elements that form positive ions (or ammonium) and 10 different elements that form negative ions (or negative polyatomic ions). Have students predict possible combinations of positive and negative ions from these. Have students check on a web periodic table to see if their combinations actually exist and if there is a use for each of their ten compounds. • Provide students with file cards (approx 30) and have the groups produce 'cards' for 10 different ion combinations, for example: - one Na^+ card and one Cl^- card is one combination (2 file cards) - one Al^{3+} card and three Br^- cards is another combination (4 file cards) • Ask student groups to demonstrate their 'card' arrangements to other student groups. The cards and arrangements can be evaluated for - the correct number of ion cards for each compound - their attractiveness - the example provided
• Have students examine a chemical name (e.g., sodium chloride). Ask the following questions: - What happens to the first element's name? - What happens to the second element's name? Guide them to this general 'rule': **monovalent metal with a non-metal:** the name of the metal does NOT change and the non-metal ending is changed to "ide." Repeat this strategy with two more examples to reach the rules for **multivalent metal with a non-metal**: The name of the multi-valent metal is followed by a Roman Numeral indicating the ion charge and the non-metal ending changes to "ide" (e.g., Iron (III) chloride) **either a monovalent or multivalent metal with a polyatomic ion**: The metal is handled as above and the non-metal polyatomic ion name is unchanged.	• Have students correctly name their combinations (or the combinations of other students) from the preceding activity.

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

Prescribed Learning Outcomes

It is expected that students will:

C4 describe changes in the properties of matter

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 physical properties of matter, including mass, volume, density, state at room temperature, colour, melting/boiling point, and conductivity
- ❑ differentiate between physical and chemical changes, citing observable evidence
- ❑ name the changes of state of matter, and describe how the kinetic molecular theory explains those changes

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Discuss with students some changes of state of matter (e.g., snow melting, making ice at a hockey rink, clothes drying on a clothesline in winter, ice cubes shrinking in the freezer), and discuss how the kinetic molecular theory explains those changes. Ask them for examples in their own experience.	• Provide students with mismatched terms and definitions for changes of state, and have the cut and paste them into correct pairings in their notebooks. Ask them to annotate each phase change, noting whether or not thermal energy is added or removed. Have students exchange their work with a partner to assess for accuracy.
• Have groups of students research specific physical properties of matter, such as density, melting point, boiling point, colour of chemicals, crystalline shape of chemicals, state, and solubility. Aspects of the topic that might be covered could include - definition - trends among chemical families or groups - examples - practical applications	• As an assessment instrument have students present their research in a Poster Presentation format and assess it using the Poster Presentation Scoring Guide.

• Provide students with definitions and criteria to distinguish a chemical from a physical change. - **physical change**: the substance undergoing the change remains the same substance, even though it may have changed state or form (e.g., melting, dissolving) - **chemical change**: the substance undergoing the change becomes one more new substances with different properties from the original Criteria for a chemical change: 1 colour change 2 heat, light, sound produced (consumed) 3 bubbles of gas form 4 a precipitate forms 5 difficult to reverse	• Have students complete a graphic organizer to compare chemical and physical changes. Use the Comparison Chart to assess student work. • Provide students with examples of chemical and physical changes, and have them sort the examples into the categories: chemical or physical. Have them support their choice using 'criteria' provided, such as - lighting a match (chemical, because the colour of the match wood changes - heat and light are produced in the burning although no bubbles of gas form and no precipitate forms - burning is very difficult to reverse
• Explore with students some of the applications of knowledge about chemistry. For example, ask them to identify Aboriginal technologies that involve application of chemical understanding (e.g., curing or tanning hides, preserving food, creating dyes from plants, employing plants for medicinal purposes) and explain the changes in matter that occur as a result.	• Give feedback on examples provided by students, considering the extent to which they - correctly identify technologies that use chemistry (e.g., preserving foods using oils or fats, smoking, drying, etc.) - explain what kinds of changes occur in materials or products associated with those technologies (i.e., change of state, physical changes, chemical changes)

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

Prescribed Learning Outcomes

It is expected that students will:

C5 explain the production, transfer, and interaction of static electrical charges in various materials

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, with illustrations, how static charges are separated because of transfer between various materials
- ❑ describe types of static electrical charge (positive, negative) and no charge (neutral) with reference to atomic theory
- ❑ describe how the electric force between two objects depends on types of charge, size of charge, and the distance between the two objects

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Demonstrate static electricity to students using a Van de Graaff generator or Wimshurst machine, showing the charge is stationary until given a path to ground. Rub a vinyl strip with fur or wool and show how it affects an electroscope. Using several rubbing materials (paper, polyester, hair, silk, cotton, plastic, etc.), have students working in groups rub strips of vinyl, plastic, wood, various metals, glass, plastics, carbon, and glass to see if the materials become charged.	• Have students in each group record observations of what happens when the Van de Graaff generator or the Wimshurst machine is used. They should observe the response of the electroscope and draw conclusions about whether or not a charge is developed. Have students define static charge. • Ask students to complete a chart listing all the materials used and whether or not each object becomes charged. Students should determine what types of objects do or do not get charged. Notes and reports will be collected and evaluated. Is their work complete, accurate, and well organized?
• Review with students the atomic structure of the atom, illustrating how atoms become charged (i.e., by losing or gaining electrons). Using positive and negative signs, demonstrate how to sketch objects to show whether they are positively charged, negatively charged, or have no net charge (neutral).	• Ask students to draw in their journals atomic models that show the nucleus with protons and neutrons and electrons surrounding it. • Have students draw atoms and ions for the first 20 elements in the periodic table. Look for evidence that they can state the atomic number and charge of each element. • Ask students to write in their journals the answer to the following question: What happens when an atom gains or loses electrons? Answers should be accompanied by diagrams that show positive, negative, or neutral objects.

• Demonstrate the following for students: using masking tape, hang two vinyl strips over a ring stand and charge them by rubbing them with wool. Ask students: Do they attract or repel? Repeat, rubbing acetate with silk on a second ring stand. Ask students to observe what happens when the acetate strip is brought close to the vinyl strip. Do they attract or repel? • Have students charge a balloon by rubbing it against hair, then bringing it close to the blackboard or glass. • Conduct a demonstration with a Wimshurst machine by turning it slowly then faster. Have students observe in which case the sparks jump a greater distance and suggest an explanation. • Have students use a piece of wool to rub a vinyl strip, first gently, then more vigorously. Each time, they should bring the strips to a set distance from the ball of an electroscope. Ask students the following: - In which case do the leaves of the electroscope move further apart? - Where is the greater amount of work done and which strip has the greater charge?	• Working in groups, have students record in their journals observations from the experiments. When assessing student journals look for inclusion of the following: - information on which objects attract or repel - information about the effect of the size of charge and how distance affects the force of attraction or repulsion - a record of situations when the force greater or lesser • Have students draw conclusions about attraction and repulsion. Assess the extent to which they recognize how the electric force between two objects depends on types of charge, size of charge, and the distance between the two objects.

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

Prescribed Learning Outcomes

It is expected that students will:

C6 explain how electric current results from separation of charge and the movement of electrons

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:

- ❑ distinguish between
  - potential and kinetic energy
  - static electricity and electric current
  - conventional current and electron flow
- ❑ relate the charge on electrons to electron flow in a circuit (i.e., from negative to positive)
- ❑ define *current* in terms of the amount of electric charge that passes a point in a given time interval

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Review with students the definitions of *force*, *types of energy*, and *static charge*. Ask students "When an object has a static charge, where are the charges positioned?" Discuss repulsion of like charges. "What if you touch the charged object or give the charge a path (wire) to ground?" Discuss grounding.	• Assess whether students' answers to questions show that they understand the difference between kinetic and potential energy with respect to static electric charges and electric current. • Have students draw and label diagrams that illustrate forces, energy, and charge (static and moving). Verify accuracy.
• Explain that electrons flow as a result of attractive and repulsive forces acting on them. Briefly explain how *voltage* is a description of the amount of energy of a charge (i.e., due to the separation of charges). Ask, "How can energy be given to a charge?" Demonstrate and explain some different types of power supplies, energy converters, and generators. Then show students the symbols used in circuit diagrams and how to measure voltage of cells using a voltmeter.	• Assess students' understanding of energy generation by considering how many different ways of giving energy to a charge they can identify (e.g., rubbing two materials, using a chemical cell, a generator, thermocouples, piezo-electric device, photo-electric cell).
• Have students use a voltmeter to measure the voltage of cells connected in series and in parallel.	• Have students draw circuit diagrams to represent their work with cells and voltmeters. Assess the extent to which their diagrams - show the correct arrangement of cells in series and parallel - use proper symbols for devices used - include proper voltmeter readings (with units) - include conclusions about the differences in voltage when cells are connected in series and parallel

• Define current for students as a rate of charge flow (the amount of electric charge that passes a point in a given time interval). Explain that historically (before the time of Coulomb), people believed that positive charges flowed through a wire (conventional current). Compare this with the modern understanding (flow of electrons). • Instruct students in the correct use of an ammeter.	• Have students use an ammeter to measure total current in a series circuit vs. a parallel circuit as more devices (resistors, light bulbs) are added (voltage is kept constant). Have them record observations using circuit diagrams and draw conclusions. Assess their work by considering whether they have - properly connected the ammeter - obtained reasonable measurements - drawn symbols correctly - recognized how current changes when devices are added in both series circuits (current decreases) and parallel circuits (current increases) Consider using the Lab Report Performance Task Definition and the Lab Report Scoring Rubric provided at the end of the Classroom Model for this grade.

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

Prescribed Learning Outcomes

It is expected that students will:

C7 compare series and parallel circuits involving varying resistances, voltages, and currents

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 *resistance*
- ❑ draw circuit diagrams using appropriate symbols that are properly placed
- ❑ conduct experiments to
  - measure voltage and current, using appropriate equipment and units (e.g., volts, amperes)
  - determine resistance, using current and voltage data
- ❑ perform calculations using Ohm's Law
- ❑ for a fixed supply voltage, differentiate qualitatively between series and parallel circuits in terms of
  - current (may change from resistor to resistor in parallel; remains the same in series)
  - voltage (may change from resistor to resistor in series; remains the same in parallel)
  - total resistance (increases with the number of resistors in series; decreases in parallel)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Ask students "If power supplies give energy and a voltage increase to charges, what are devices called that take away energy?"	• Students (in groups) will brainstorm and list objects that take energy from a charge. They will generalize and call them resistors. Their observations and definition will be recorded in their journals. Assess by considering how many different devices students can come up with.
• Display a circuit and show how the corresponding circuit diagram is drawn, using standard symbols to show power supplies or cells connected in series, wires, resistors, and voltmeters and ammeters correctly connected.	• Have students set up their own circuit following the circuit diagram presented. Provide assistance as required. Ask students to - measure the voltage across a power supply and current through it for at least five different voltages and record the data. (they can increase voltage by adding more cells in series or changing the setting on the power supply) - determine the voltage-current ratio for each trial and record data in their data table If they are able, they should measure the resistance of the resistor using an ohmmeter. Have students examine their data to see what is constant and draw conclusions. Assess whether - they conduct the set up carefully - provide accurate data and diagrams - draw conclusions that correspond to the substance of Ohm's Law Provide help with the activity and with concept development as necessary.

• Review Ohm's Law and units. Demonstrate several examples of problems involving Ohm's Law and including unit prefixes such as milli, mega and kilo.	• Students complete Ohm's Law problems and submit for marking. Award marks for proper use of units and showing work, as well as obtaining correct results.
• Demonstrate for students - 1, 2 and 3 resistors connected in series and parallel (keep the terminal voltage constant throughout) - the proper use of voltmeters and ammeters in these circuits (voltage and current are measured in each circuit and across each resistor and power supply) • Follow up by using Ohm's Law to calculate total resistance in the circuit using the terminal voltage and the current readings from the power supply.	• Have students, working in groups, draw diagrams of each of the circuits demonstrated. Have students record the terminal voltage, the voltage across each resistor, and the current through each resistor. Verify for accuracy. • When assessing student work, look for their ability to - identify patterns in their data - state what happens to current, and voltage in the circuits and how they changed (or did not change) in each series and parallel circuit • Students should recognize that - in a series circuit, the total resistance has increased as resistors have been added in series - in a parallel circuit resistance has decreased as resistors have been added in parallel

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

Prescribed Learning Outcomes

It is expected that students will:

C8 relate electrical energy to power consumption

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 electrical energy and power
- ❑ calculate the following:
  - power—using voltage and current data
  - energy consumption—given the power rating of a device and duration of use

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Review ways electricity is generated (dry cell, static electric charges, thermocouples, piezoelectric crystals, solar cells, and electric generators). Show students a video on hydroelectric generation as well as other possible forms of electric energy generation (solar, wind geothermal, etc.). Alternatively, set up stations for each of several generation systems. Have students circulate through the stations and complete reports in which they identify for each system, as appropriate, - the size of cells - number of cells - temperature difference - size of magnet - number of coils - speed of rotation of coil or magnet	• Have students draw diagrams and explain how different devices generate electricity and the factors that affect how much electricity is generated. If a stations approach is used, student reports can be assessed on accuracy of observations and factors that affect current and voltage generation.
• Remind students of the differences between energy and power. Review definitions for force, work, energy, power, voltage, current, resistance, and the appropriate units for each. • Define electrical energy and power using their formulas. Demonstrate how to solve problems using $E = VI\Delta t$ and $P = VI$. Explain the use of kW•h and J for energy and W, kW, and MW for power. • Ask students to observe their home energy consumption for a week, record the daily readings, and determine the cost of their electrical energy. • Have students construct a concept map for all the terms listed in the vocabulary for this section.	• Have students write definitions and solve problems with respect to electrical energy and power and duration of use. Verify that students use appropriate units, including kilowatt, megawatt and kilowatt-hour as well as the power rating of devices. Award marks for proper use of units and showing work, as well as obtaining correct results. • Assess the energy consumption records for organization, completeness, as well as correct calculations and use of appropriate units. • To assess students' concept maps, use the concept map rubric provided at the end of the Classroom Model for this grade.

GRADE 9

KEY ELEMENTS: EARTH AND SPACE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have examined the formation, composition, and characteristics of the solar system, stars, and universe.

Vocabulary

asteroids, axis tilt, Big Bang, colonization, comets, constellations, Copernicus, galaxies, Kepler, moons, nebulae, planets, probes, Ptolemy, revolution, rotation, satellites, solar and lunar eclipses, spectroscopes, star clusters/types, Sun, telescopes, terraforming

Knowledge

- technologies advance understanding of the solar system, stars, and universe
- components of the universe and solar system
- significance of Earth's rotation, revolution, and axis tilt
- celestial sphere in relation to constellations and their location
- motion of constellations, planets, moons, sun, asteroids, and comets
- solar and lunar eclipses
- implications of space travel

Skills and Attitudes

- illustrate astronomical phenomena
- show respect for Aboriginal perspectives
- identify ethical considerations associated with space travel

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

Prescribed Learning Outcomes

It is expected that students will:

D1 explain how a variety of technologies have advanced understanding of the universe and solar system

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 and describe a range of instruments that are used in astronomy (e.g., telescopes, spectroscopes, satellites, probes, robotic devices)
- ❑ give examples of how astronomers use astronomical and space exploration technologies to advance understanding of the universe and solar system (e.g., using red shift to support the idea of an expanding universe, using parallax to measure distance)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Provide any or all of the following instruments for examination: binoculars, reflecting or refracting telescope, spectroscope, compact satellite dish. Using cross-section diagrams, illustrate how reflectors and refractors as well as radio telescopes collect information from the night sky.	• Students should be able to draw: - the correct arrangement of lenses for refracting telescopes - the correct arrangement of parabolic mirror, plane mirror, and lens for reflecting telescopes - the appropriate shape of dish and position of receiver for radio telescopes - using cross-section diagrams, the method by which each instrument collects light rays and/or radio waves
• As a class activity, set up a gas discharge tube apparatus. With tubes of different elements, have students use spectroscopes or diffraction gratings to observe the unique spectra of light colours produced by each glowing gas. Explain that each element produces its own "fingerprint" of colours, and that by using spectroscopes to observe stars, scientists can determine which elements are burning in those stars.	• Have students draw the patterns of spectra for each gas as well as for white light. These can be collected and assessed for accuracy and neatness.
• Have students perform research on one or more instruments used in space to gather information (e.g. probes, satellites, robotic devices such as Canadarm or the Mars explorers). They can build models or draw accurate diagrams of the instrument studied and present their findings to the class.	• Assess student work based on - the detail, neatness, and proper labelling in the model or diagram - the description of purpose(s) for the instrument - inclusion of information on what data have been gathered or what important work has been done to date by the instrument

• Explain Red Shift by demonstrating the Doppler Effect to students: spin a buzzer (tied to a string) over your head in a horizontal circle. Students should notice a clear difference in pitch as the buzzer twirls alternately toward, then away from the class. Explain that to a stationary observer, waves produced by an approaching object bunch up and become shorter, and conversely spread out when the object moves away. Since light is a wave, the light produced by galaxies across the universe is always “stretched out” to the longer-wave red end of the visible spectrum, indicating an expanding universe. From this, students should be able to infer that in the past, the universe was much smaller. Explain that many scientists believe the universe started as a massive explosion called the Big Bang, with its galaxies continuing to spread out today.	• Given a variety of examples, students should be able to describe an object’s motion as either approaching or receding from a stationary observer. Such examples can include (but are not limited to) the following: - a map view of water waves from a drifting canoe or kayak (symmetrical shape otherwise makes it difficult to tell direction of motion) - the changing pitch of a train horn as it passes a stopped car at a railroad crossing - the red or violet shift of light patterns produced by various stars moving relative to Earth
• Have students place their index finger at arm’s length in front of their face. With one eye closed, have them line their finger up with a distant object across the room. Without moving, have them switch eyes and describe what they see. They should be able to describe that the finger appears to have shifted position, due to the different position of their other eye. Explain that stars in close proximity to us also appear to shift position (relative to more distant stars) as we revolve around the Sun, and that by measuring the shift and using some basic geometry skills, the distance to nearby stellar objects can be determined. • As an extension, have students use the edges of a rectangular desk or table placed at one end of the room to determine the overall length of the room, using triangulation.	• Given the amount of apparent shift of various stellar objects, students should be able to qualitatively arrange the objects in order from closest to furthest away from Earth. • In their work, students should include - a map diagram of the room and desk position, with lines drawn to show the similar triangles used (with appropriate dimensions) to find room length - calculations used based on the principle of similar triangles to determine room length

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

Prescribed Learning Outcomes

It is expected that students will:

D2 describe the major components and characteristics of the universe and solar system

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 galaxies, star clusters/types, planets, constellations, nebulae according to their distinguishing characteristics
- ❑ relate mass to different stages in the life cycle of stars
- ❑ describe theories on the nature of the solar system (e.g., Ptolemy, Copernicus, Kepler)
- ❑ describe the formation of the solar system (e.g., condensing nebula) and its components (e.g., planets, moons, comets, asteroids, the Sun) and the formation of the universe (e.g., Big Bang)
- ❑ describe the processes that generate and events that distribute the energy of the Sun and other stars (e.g., nuclear fusion, solar flares and prominences, sun spots, solar wind)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Have students construct a mind map organizing all the components of the universe, using diagrams and links to connect the terms. As they work through the process, explain the way in which the universe is organized, from large (galaxies) to small (our solar system, Earth).	• Maps should include all appropriate terms arranged to clearly show the constituent parts of the solar system, our galaxy, the local group of galaxies and finally, the universe.
• As another introductory exercise, provide students with three sets of cards to match up. Set A can be illustrations or photos of various stellar objects; set B can be descriptions; and set C, the names. The stellar objects can include: - different patterns of galaxies - nebulae - stars showing various sizes and colours/temperatures (e.g., red dwarf, blue giant) - common constellations (e.g., Big Dipper, Orion) - the planets of our solar system It may help to initially have students arrange the cards into categories of stars, constellations, planets, galaxies, etc. Once completed, go over the exercise. This can be repeated as a test once the section is finished.	• Assess students on their ability to - classify and distinguish between galaxies, stars, constellations, nebulae and planets - differentiate between types of galaxies - identify star types - name and identify the planets of the solar system - define and give examples of dwarf planets

• Compare the life of a star to the fuel consumption in a motor vehicle. Given a large SUV, a medium-sized sedan and a small economy car, ask the following: - which vehicle has the most power and energy? - which vehicle is the slowest? - which vehicle will travel the furthest on one tank of gas? Explain that stars generally fall into three categories: the largest stars, which give off the most energy but use up their fuel quickly and explode into supernovas; medium-size stars like our sun, that burn their fuel more slowly until they eventually become red giants and white dwarfs; and small red dwarf stars that give off relatively small amounts of light but live the longest.	• Assess students on their ability to - classify stars according to size as well as brightness/temperature (e.g., blue and red giants, white dwarfs, red dwarfs) - indicate the relative age of each type of star - describe the historical and future sequence of events for each type of star - distinguish between the relative length of life for each type of star
• Have students conduct research on the two historic models of the solar system (geocentric and heliocentric) and report on the astronomers who supported each model, as well as the underlying reasons for that support (e.g., observation and scientific reasoning vs. other beliefs).	• Reports on a historical astronomer should include the following information: - an explanation of geocentric and heliocentric models of the solar system - the prevailing wisdom during that astronomer's time - underlying reasons for the person's theories or beliefs - strengths/weaknesses of that person's theories or beliefs
• Illustrate the stages of formation of the solar system: - the condensing of a rotating disk of gas and dust due to gravity - accumulation of enough matter to ignite nuclear reactions - blowout of the lighter hydrogen and helium elements to the more distant edge of the disk - condensation of these lighter but more abundant elements into gas giants - condensation of closer but less abundant heavy elements (including metals, oxygen, silicon) into terrestrial planets	• Students should be able to place stages in the correct order, and can be expected to explain why, according to the nebular theory of our solar system's formation - there are distinct groups of planets - the outer group is made of mostly lighter gaseous elements like hydrogen and helium - the terrestrial group is much smaller in size - Pluto and other similar bodies are defined as dwarf planets As an extension, have students research other classification systems for planetary-type bodies.

• Take students out to a field. Place one student, as the Sun, on one end of the field. Using a scale of 1 astronomical unit = 3 m, place other students, representing Mercury through Neptune, at appropriate distances from the "Sun". This exercise gives students a reasonable perspective as to the vast size of the solar system. As an extension, have students try to determine how far away one would stand from the Sun to represent Alpha Centauri, the closest star to us. Back in class, have the students draw a map of the field to scale, showing the correct positions of each planet and the Sun.	• Drawings should be neat, with scale clearly shown, proper labels and positions marked, as well as the true distances from the Sun to each planet indicated.
• Have students conduct research and report on early stages of the formation of the universe.	• Assess student research reports, considering the extent to which they have - consulted a variety of sources and cited them correctly - identified the main points in science-related sources they have cited - clarified assumptions (their own and those of authors, as appropriate) - clearly and accurately explained fundamental concepts (e.g., re the Big Bang) - identified supporting or refuting information and bias pertinent to their argument - identified the roles of science and technology in contributing to the knowledge base they are presenting
• Draw a cross-section diagram of the Sun, illustrating its major components. Explain how energy is produced by nuclear reactions involving lighter elements in the interior of the Sun and other stars, and that this fuel is finite. Explain the concept of nuclear fusion (in simple terms) and tell students that fusion is the energy-producing system that takes place in the interior of all stars, made possible by the incredible temperature and pressure from overlying matter that crushes hydrogen and other nuclei into each other in a star's interior. Also explain that this lack of matter inhibits the fusion process from occurring in hydrogen-rich gas giants like Jupiter.	• Students should be able to label the Sun's basic surface features, and explain why factors such as temperature and pressure will determine a celestial body's ability to generate nuclear fusion. As an extension, students could be challenged to explain how these factors (e.g., temperature and pressure) make the fusion process so difficult to achieve on Earth.

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

Prescribed Learning Outcomes

It is expected that students will:

D3 describe traditional perspectives of a range of Aboriginal peoples in BC on the relationship between the Earth and celestial bodies

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 passages related to the relationship between the Earth and various celestial bodies within specific traditional stories of BC Aboriginal peoples
- ❑ respond to BC Aboriginal stories and presentations focusing on the nature of stars, the moon, planets, comets, or eclipses (e.g., by creating illustrations; by identifying similarities among stories or between stories and contemporary scientific understanding)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Show students a star map to analyze and consider the origins of the most common constellations in the night sky. Students should be able to identify characters of Greek, Roman, or Middle Eastern mythology. Explain that most of the characters depicted in star maps are derived from these ancient cultures and civilizations, and that other cultures will not see star patterns the same way; their stories concerning the formation of the Earth, Sun and universe will tie into their own star patterns and be quite different from the beliefs of the early European and Middle Eastern cultures.	• No assessment here.
• Have students perform comparative research on the different astronomy-related stories of various aboriginal cultures. Material gathered could include - Haida and Kwatiutl stories of Raven stealing the Sun and Moon to tempt the first humans out of a clam shell - stories from a local First Nation • As an extension, compare these stories with those of other cultures (e.g. Druids and Stonehenge, the ancient Greeks, Polynesians)	• Reports can be presented to class or submitted as written assignments, with the focus placed on similarities and differences between the stories (e.g., the central characters or themes, details re the formation of the Sun, Moon, and Earth). Assessments should consider level of detail provided, use of sources (authenticity), and identification of similarities and differences.

• Invite an elder from a local band to class to discuss the astronomical folklore of the local peoples. Students should take notes about the salient points. Alternatively, visit a local museum and have a local expert provide a tour and/or lecture about local astronomical beliefs. Ask students to submit 2-3 questions from the lecture that will be used to make up a quiz.	• Students should display an ability to - describe several characters in the stories and their relationships to astronomy - respect beliefs that are different than their own - value the input provided by elders and/or experts in the field
• Brainstorm and discuss other uses of astronomical knowledge by BC Aboriginal peoples (i.e., beyond using it in stories).	• Look for students to identify uses such as the following for astronomical knowledge: - travel (i.e., using the sun, moon, and stars as guides) - marking the passage of time (e.g., determining harvesting and hunting seasons)

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

Prescribed Learning Outcomes

It is expected that students will:

D4 explain astronomical phenomena with reference to the Earth/moon system

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 the formation of the Earth's moon, with reference to supporting evidence
- ❑ describe the significance of Earth's rotation, revolution, and axis tilt (e.g., seasons, day/night)
- ❑ describe the celestial sphere in relation to constellations and their locations
- ❑ explain the apparent motion of constellations, planets, the Sun, the moon, asteroids, and comets
- ❑ explain and illustrate solar and lunar eclipses

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Ask students to brainstorm ideas as to why Earth has such a large moon compared to its size (in relation to the other terrestrial planets). Explain that many hypotheses have emerged over the years, but current thinking is that during the early stages of formation, a large body collided with Earth, sending a large molten chunk of the mantle into orbit around the Earth, eventually forming the moon.	• Given a list of several scenarios for explaining the formation of the Earth-Moon system, have students - list the relative strengths or weaknesses of each hypothesis - rank the credibility of each hypothesis and explain the rationale for their ranking Note that the list is subjective, and a student should not be penalized for their choices so long as the explanations are reasonable.
• Ask students the following questions: - What causes day and night? - What causes seasons? - What causes stars and constellations to change position in the sky throughout the night? - Except for circumpolar constellations, why don't we see the same constellations at night throughout the year? - Why doesn't the north star change position (i.e., except over thousands of years)? Explain that all of these apparent motions and phenomena are due to three factors: Earth's revolution around the Sun, its rotation on an axis, and the tilt of its axis relative to its orbital motion.	• Assess students on their ability to correctly list and explain the factors that cause each phenomena to exist: - day and night: rotation - seasons: all three factors - changing position of stars/constellations: rotation - changing view of constellations throughout the year: revolution and rotation - stationary north star: tilt of axis

• Show students a star map. Have them locate and identify some major stars and constellations, including: Polaris, the Big Dipper (Ursa Major), the Little Dipper (Ursa Minor), Cassiopeia, Orion, Deneb, and one or two zodiac constellations. Then, have students research which celestial bodies are visible in early evening at their present date. Finally, organize a night gathering in early fall or late winter, when the Sun is fully set in the evening on a clear night. Bring a good telescope and have students locate and observe various stars, constellations and planets, including the one they were expected to see. Have students construct field notes that include a sky map illustrating direction and labelling several significant objects observed.	• Students will be expected to produce a detailed set of notes describing the location of the gathering, date and time, as well as a well-drawn map accurately showing correct locations of the objects observed, relative to north.
• Shine a bright light on a golf ball against the blackboard. Point out the dark interior shadow and the more faded outer shadow of the golf ball. Draw a ray diagram illustrating the full interior shadow as well as the partial outer shadow. Next, ask students to relate these shadow regions to total and partial eclipses of the Sun and Moon by drawing ray diagrams and noting the Sun-Earth-Moon positions in each case.	• Assess students' ability to draw - a solar eclipse, with Sun, Earth, and Moon in correct positions, and rays showing regions of total and partial eclipse - a lunar eclipse, with Sun, Earth, and Moon in correct positions, and rays showing regions of total and partial eclipse

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

Prescribed Learning Outcomes

It is expected that students will:

D5 analyse the implications of space travel

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 various possibilities and limitations associated with space travel (e.g., with reference to factors such as time, essential human needs, robots, budget choices, militarization of space)
- ❑ debate a range of ethical issues related to space travel (e.g., appropriateness of terraforming another planet, exposing humans to risks)
- ❑ research current ideas or initiatives for further space exploration (e.g., space elevator, colonization of other planets, search for extraterrestrial life)

PLANNING FOR ASSESSMENT	ASSESSMENT STRATEGIES
• Have students perform various experiments that illustrate some aspect of rocketry, including: - building a Hero engine by using nails of different sizes to poke slanted holes in the bottom of used clean pop cans, filling the cans with water, tying their tabs to a fishing line and observing the amount of spin produced as the water pours out of the holes - wrapping and taping bond paper around a pencil, removing the pencil, designing various nose cones and fins to attach to the tubes, and launching them horizontally by placing straws in the tube and blowing on them to see how far they travel - constructing similar rockets as above, but with the body tube wide enough to fit a film canister filled with water and inserted with different amounts of antacid tablets to act as the launch fuel Each experiment could be performed as a formal lab, a contest, or a combination of both.	• Formal lab writeups should include: - explanations of apparatus construction - diagrams of the models, including labels - analysis of results, including reasons for the relative success or failure of a particular design In the rocket-building exercises, prizes could also be awarded for creative design, most efficient use of materials, distance travelled, etc.

• Have students perform research and either write a report, build a static or working model, create a poster or do a powerpoint presentation on one of the following topics: - the development of modern rocketry - the early development of the Russian space program, including Sputnik and Luna spacecrafts - the NASA Mercury program - the NASA Apollo program - the NASA space shuttle program - various space station programs, including Soyuz, Skylab, Mir and the ISS (International Space Station) - Canada's contribution to various space programs (e.g. Marc Garneau, Canadarm) - setbacks in space travel (e.g. space shuttle disasters) - unmanned space missions (e.g. Voyager, Hubble, Mars Explorers) - the future of space missions (e.g. manned and unmanned travel, space stations) Each project should be presented to the class and discussed as a group.	• Assess students on the following: - amount of research performed (e.g. how many and types of sources) - clarity of presentation - interest level of audience in presentation

CHARTING ION CHARGE

(Italics indicate completed student work.)

Element name	**Element Symbol**	**# of electrons in the outer shell**	**Number of electrons that could be lost or gained**	**Does the element lose or gain electrons?**	**Ion charge**
Aluminum	*Al*	*3*	*3*	*lose*	Al^{3+}
Oxygen	*O*	*6*	*2*	*gain*	O^{2-}
Chlorine	*Cl*	*7*	*1*	*gain*	Cl^{-}

POSTER PRESENTATION SCORING GUIDE

Criteria		Performance	Indicators	
	Unsatisfactory **1 mark**	**Satisfactory** **2 marks**	**Good** **3 marks**	**Excellent** **4 marks**
Research credited (notes provided)	no bibliography or notes given	some references included and notes	all references given, sketchy notes	all references given and notes show clear understanding
Appropriate detail and depth of knowledge	some details of the topic provided	either too much or too little detail	depth of content is appropriate for the audience	appropriate depth makes the presentation memorable
Organization of presentation	ideas presented in no particular order	most ideas 'flow' from one to another	ideas are presented logically	presentation leads the audience to a thorough understanding
Visual impact of poster	few images provided and explanations are sketchy	poster has images, colour and some explanation	images and explanations are related and easy to see	explanations well supported by images - poster captures attention of audience
Creativity in poster and presentation	little imagination throughout the presentation	examples used explain the topic poorly	examples or extensions relate well to the topic	examples and extensions are exceptionally relevant

COMPARISON CHART

(Text in italics represents the sort of response that might be expected of students.)

Physical Change		**Chemical Change**
	How are they alike?	
	Both involve chemicals. *Boiling produces bubbles, so do some chemical changes.* *Heat is needed or removed for changes of state and heat is involved in some chemical changes.*	
	How are they different? with regard to	
New materials are not formed. *The same type of matter is present before and after the change.*	materials formed	*New materials are formed.* *Different type(s) of matter are present before and after the change.*
The properties of the substances involved have not changed.	properties	*The properties of the substances formed in the change will be different from those before.*
Physical changes are relatively easy to reverse: - *add or remove heat for changes of state* - *remove water after dissolving.*	evidence	*Chemical changes are difficult to reverse:* - *colour change* - *heat, light, sound produced (consumed)* - *bubbles of gas form* - *a precipitate forms.*
changes of state (e.g., melting; dissolving)	examples	*burning a match*

Conclusion

Chemical and physical changes can be confused, but only chemical change involves a permanent change in properties.

LAB REPORT: PERFORMANCE TASK DEFINITION

Name | Block
Lab Number | Date

[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/ felt/ 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 : (complete the sentence)
   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

	Beginning 1	*Developing* 2	*Accomplished* 3	*Exemplary* 4	*Score*
Purpose	Purpose is not written.	Purpose is written but the desired relationship is not stated.	Purpose is stated identifying the relationship to be determined.	Purpose is stated, clearly identifying the relationship to be determined and written in 3rd person passive.	
Procedure	Procedure is not written.	Procedure is written but the processes to be followed are not clear.	Procedure is written and the processes to be followed are easy to follow.	Procedure is written. The processes to be used are easy to follow and include other options to pursue.	
Observations, Data and Diagrams	Observations, data and diagrams are not included.	Observations, data and diagrams are included but are incomplete and/or messy.	Observations, data, and diagrams are included and are complete and neat.	Observations, data, and diagrams are included and are complete and neat. A pencil and ruler have been used when required.	
Questions and Answers	Questions and answers are not included.	Questions and answers are included but are incomplete.	Questions and answers are included and are mostly complete.	Questions and answers are included and are complete.	
Conclusion	Conclusion is not included.	Conclusion is included but is incomplete or has personal opinions such as “It smelled yucky” or “I liked this lab.”	Conclusion is included and is complete in 3rd person passive.	Conclusion is included. It is complete, written in 3rd person passive, and includes suggestions for future experiments.	
Total Score =					

CONCEPT MAP RUBRIC

Criteria	*Performance Indicators*			
	Does not meet expectations	**Minimally meets expectations**	**Fully meets expectations**	**Exceeds expectations**
Title and title image	unclear, hard to distinguish from other info	clear, but not eye-catching	clear, uses an image that relates to the key idea	stands out attracting attention, uses symbolism or humour
Ideas branch down from the title image with increasing detail	little logical order, lack of detail	ideas branch but are sometimes confusing, some supporting detail is provided	ideas are logically connected and show more detail as they branch	ideas are logically connected and accurately give more detail as they branch
Connecting words or phrases are appropriate and indicate understanding	few linking connecting words or phrases	connecting works are present, but there are few or they don't truly link the ideas	connecting words show understanding, but some could improve	connecting words are obvious and clearly relate to the concepts
Ideas are coded with colour	little or no use of colour or other code to connect sections of the concept map	colour or coding is used to link sections of the concept map, but is confusing	colour or coding for sections of the concept map is clear and will help with memory	the use of colour or coding is effective in making the connections memorable
Main ideas have appropriate illustrations	no illustrations	some key ideas are illustrated, some images are irrelevant	concept map illustrates all the key ideas and some of the supporting details	images are clear and lead to an understanding of content

LEARNING RESOURCES

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.

What Are the Criteria Used to Evaluate Learning Resources?

The Ministry of Education facilitates the evaluation of learning resources that support BC curricula, 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.

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

GLOSSARY

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.

A

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.

B

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.

C

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.

climate
Weather conditions in an area, including rainfall and temperature.

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.

D

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/cm^3.

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., $AB + CD \rightarrow AD + CB$).

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

E

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.

F

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.

G

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.

H

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.

I

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 r 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.

K

keystone species
A particular type of organism that exerts great influence on an ecosystem relative to its abundance.

L

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.

M

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 sold 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.

N

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.

O

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.

P

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/cm^2.

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.

R

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

S

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 –regenerating 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.

T

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 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.

U

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

V

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 (cm^3).

W

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

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

Z

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