Science 8

Curriculum Guide

NOVA SCOTIA
NOUVELLE-ÉCOSSE

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Prepared by the Department of Education and Early Childhood Development

This is the most recent version of the current curriculum materials as used by teachers in Nova Scotia.

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Background

An important and universal goal of science education is to equip learners with an understanding of the roles that science and technology play in society. The Nova Scotia science curriculum aims to develop learners' Scientific Literacy and their ability to problem solve and apply the principles of scientific inquiry to real-world situations and familiar problems. In so doing, learners will develop skills and competencies. Additionally, Science 8 seeks to develop scientific literacy through designing and building for technological innovation, writing for scientific communication and data analysis.

Learners in grade 8 will have opportunities to design scientific inquiries, evaluate evidence, use evidence for argumentation and use technology to solve problems. They will explore fundamental concepts of the Nature of Science such as:

- Scientific Reasoning
- Patterns
- Cause and Effect
- Systems and Models
- Energy and Matter
- Structure and Function
- Change and Stability
- Stewardship and Sustainability
- Similarity and Diversity

Learning in Context:

The nature of science asks learners to question the phenomena of the world around them, then test those questions in controlled environments. Themes create authentic purpose for learning and facilitate cross curricular, project-based learning opportunities. Learners will see the context for what they are learning which will improve transfer of skills and knowledge. It is important that learners view themselves as scientists and as an integral part of the learning process. Teaching through themes is one way to make the learning meaningful for all learners. Each of the themes in Science 8 provide opportunities for learners to engage with inquiry based learning in a hands-on way that is crucial to science literacy and the development of critical thinking skills.

Science 8 Themes:

- *Healthy Cells, Healthy Systems* - Learners explore concepts related to keeping their bodies healthy. They will learn about cell structures and functions in relation to various medical disorders. Learners will employ case study methodologies.
- *Climate Change* - Learners will explore concepts related to heat and the kinetic molecular theory in relation to climate change and the greenhouse effect. They will examine the role of humans in climate change as well as potential solutions for adaptation and mitigation.
- *Hydraulics and Pneumatics* - Learners will explore concepts related to the properties of fluids and fluid dynamics as they are applied in hydraulic and pneumatic systems. Learners will explore mechanical advantage provided by these systems and they will use the design process to create a hydraulic or pneumatic system to solve a problem.

Learning through the lens of Competencies and Skills

In 2015 the Council of Atlantic Ministers of Education and Training (CAMET) released their findings to a review of the Atlantic Canada Essential Graduation Learnings which had been developed in 1995 as a framework for curriculum development. The review questioned whether the existing model responded to the changing demands of work and life in the 21st century. This review resulted in an updated document, the Essential Graduation Competencies, placed emphasis on the importance of articulating clear statements of what learners are expected to know, be able to do, and reflect on by the time they graduate from high school. These competencies describe expectations, not in terms of individual curricular areas but in terms of attitudes, skills, and knowledge developed throughout the curricula.

What are competencies?

Competencies are an interrelated set of attitudes, skills and knowledge that is drawn upon and applied in a particular context for learning and living. Competencies are developed over time through engagement in learning experiences and a supportive learning environment.

Citizenship (CZ)

Learners are expected to contribute to the quality and sustainability of their environment, communities, and society. They analyse cultural, economic, environmental, and social issues, make decisions, judgment, solve problems, and act as stewards in a local, national, and global context.

Personal-Career Development (PCD)

Learners are expected to become self-aware and self-directed individuals who set and pursue goals. They understand and appreciate how culture contributes to work and personal life roles. They make thoughtful decisions regarding health and wellness, and career pathways.

Communication (COM)

Learners are expected to interpret and express themselves effectively through a variety of media. They participate in critical dialogue, listen, read, view, and create for information, enrichment, and enjoyment.

Creativity and Innovation (CI)
Learners are expected to demonstrate openness to new experiences, engage in creative processes, to make unexpected connections, and to generate new and dynamic ideas, techniques, and products. They value aesthetic expression and appreciate the creative and innovative work of others.

Critical Thinking (CT)
Learners are expected to analyse and evaluate evidence, arguments, and ideas using various types of reasoning and systems thinking to inquire, make decisions, and solve problems. They reflect critically on thinking processes.

Technological Fluency (TF)
Learners are expected to use and apply technology to collaborate, communicate, create, innovate, and solve problems. They use technology in a legal, safe, and ethically responsible manner to support and enhance learning.

The renewed curriculum outcomes are comprised of skills, concepts, and opportunities for engagement with the competencies. Each outcome has suggested indicators to assist in developing those concepts and skills to demonstrate achievement. The design reflects an opportunity for a natural cross curricular approach.

- Indicators have been identified for each outcome; the indicators are aligned with competencies and are suggested ways to scaffold skill development through conceptual exploration in order to provide a depth of understanding in relation to the outcome.
- Concepts are the key ideas, information, and theories that learners come to know through the aligned skill. Guiding questions are offered as possible ways to approach learning associated with the skill and concept.

Competencies are listed at the end of each indicator. These are closely aligned with the combination of skill and concept that are found in the indicator. The competencies can be used by teachers to frame learning experiences. This framing provides opportunities for learners to engage with and develop the related competency.

Course Delivery
Learning will be enhanced through an inquiry-based approach. Inquiry-based learning requires learners to meaningfully engage in the experience/activity while reflecting upon the learning and the competencies and skills they are developing.

By delivering the curriculum through an integrated approach, higher level thinking and active participation are encouraged. This approach supports learners in a deeper understanding of content and offers expanded opportunities for achievement of outcomes in a meaningful way.

Inquiry Based Learning

Inquiry-based learning is an approach that promotes inquiry, the creation of ideas, and observation. The process typically involves investigations, aimed at answering a big question or solving a problem. These investigations require that students learn how to develop questions, look for information, and to identify possible solutions or conclusions.

Project Based Learning

Using "big ideas" as a starting point, students learn through practical projects that require them to acquire a thorough understanding of the subject that they can apply in the real world. This approach engages students in formulating questions, investigating for answers, building new understandings, communicating their learning to others, while developing critical thinking skills, collaboration, communication, reasoning, synthesis skills, and resilience. Project Based Learning typically is concluded with a final product that is presented to a school and/or a community-based audience.

How inquiry based learning benefits learners:

- Makes learning relatable and relevant for learners
- Provides motivation through contextual learning
- Helps learners integrate and practice concepts and theories learned in the classroom
- Creates opportunities for development of skills and success in learning

What could it look like in the classroom?

Learners will:

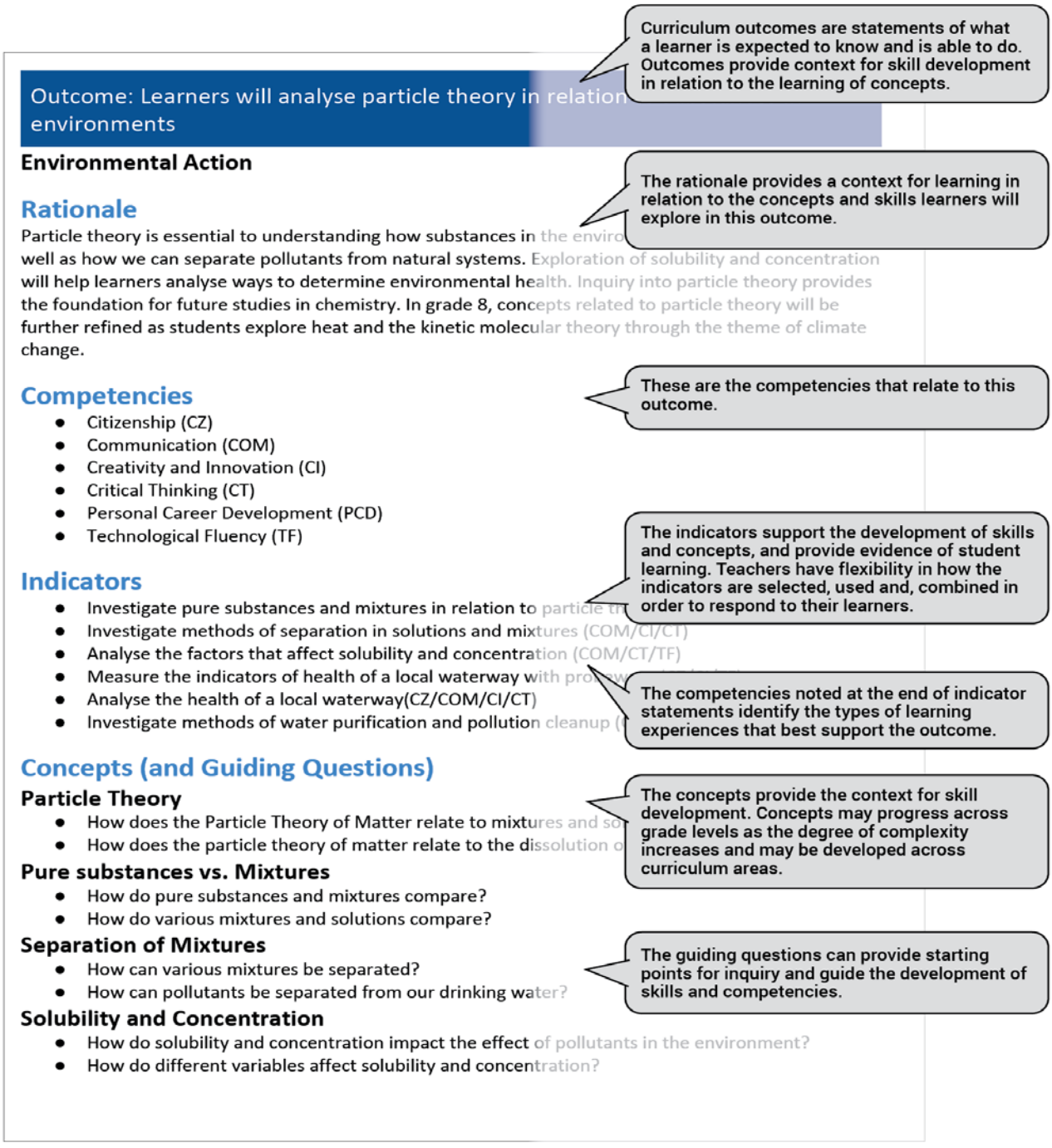
- Seek and pursue opportunities for innovation
- Introduce and test ideas
- Assess opportunities
- Set goals and action plans
- Demonstrate self-awareness
- Engage in ongoing reflection
- Take risks

How do I know it's working?

Learners are developing as:

- Flexible collaborators
- Reflective leaders
- Calculated risk takers
- Adaptive and resilient problem solvers
- Effective communicators
- Self-aware learner

How to Use This Guide



Outcome: Learners will analyse particle theory in relation
environments

Environmental Action

Rationale

Particle theory is essential to understanding how substances in the enviro
well as how we can separate pollutants from natural systems. Exploration of solubility and concentration will help learners analyse ways to determine environmental health. Inquiry into particle theory provides the foundation for future studies in chemistry. In grade 8, concepts related to particle theory will be further refined as students explore heat and the kinetic molecular theory through the theme of climate change.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate pure substances and mixtures in relation to particle th
- Investigate methods of separation in solutions and mixtures (COM/CI/CT)
- Analyse the factors that affect solubility and concentration (COM/CT/TF)
- Measure the indicators of health of a local waterway with pro
- Analyse the health of a local waterway(CZ/COM/CI/CT)
- Investigate methods of water purification and pollution cleanup (

Concepts (and Guiding Questions)

Particle Theory

- How does the Particle Theory of Matter relate to mixtures and so
- How does the particle theory of matter relate to the dissolution o

Pure substances vs. Mixtures

- How do pure substances and mixtures compare?
- How do various mixtures and solutions compare?

Separation of Mixtures

- How can various mixtures be separated?
- How can pollutants be separated from our drinking water?

Solubility and Concentration

- How do solubility and concentration impact the effect of pollutants in the environment?
- How do different variables affect solubility and concentration?

Curriculum outcomes are statements of what a learner is expected to know and is able to do. Outcomes provide context for skill development in relation to the learning of concepts.

The rationale provides a context for learning in relation to the concepts and skills learners will explore in this outcome.

These are the competencies that relate to this outcome.

The indicators support the development of skills and concepts, and provide evidence of student learning. Teachers have flexibility in how the indicators are selected, used and, combined in order to respond to their learners.

The competencies noted at the end of indicator statements identify the types of learning experiences that best support the outcome.

The concepts provide the context for skill development. Concepts may progress across grade levels as the degree of complexity increases and may be developed across curriculum areas.

The guiding questions can provide starting points for inquiry and guide the development of skills and competencies.

Determining Environmental Health

- How can the health of an environment be determined?
- How can water be kept clean for drinking and as a habitat?
- How does pollution enter the environment?

Skills

The first skill defined is the outcome skill and the others are the skills found in the indicators.

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives; communicate findings.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives, and communicate findings.

Measure

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Some courses include a table that describes the scope and sequence of the skills and concepts for this outcome.

Grade 4	Grade 5	Grade 7	
Learners will have investigated a variety of local natural habitats. Concepts included habitat components and characteristics, survival needs of organisms, how habitats can change over seasons and with time.	Learners will have tested how physical and chemical changes affect the properties of matter. Concepts included physical and chemical properties of matter, physical and chemical changes as well as conservation of mass.	Learners will analyse particle theory in relation to substances in environments. Learners will explore the following concepts: particle theory, pure substances vs. mixtures, separation of mixtures, solubility and concentration, determining environmental health.	relation to particle theory.

The background knowledge provides an overview of the learners' experiences in relation to the skills and concepts of the outcome.

Pollution provides the context for learning about particle theory in this outcome. Learners will explore the impact of various concentrations of substances in the environment. An understanding of the concept of pollution and an understanding of particle theory will support learners' scientific knowledge that underpins the concept of pollution. An understanding of pollution helps learners make decisions about what is safe or harmful for the environment.
Data logging sensors (probeware) can be used to collect data from local environments. This provides opportunities to connect with the mathematics curriculum as well as careers in environmental management. Using probeware allows for the collection of a lot of data in a short period of time so the effort can be placed in designing controlled experiments and analyzing the data for real-life implications. Learners have had probeware available to them as early as grade 4.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in exploration of skills and concepts for this outcome can be done in any or based on the progression of learning. The experience described below is the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *analyse the factors* *concentration* when *measuring the indicators of health of a local wate*

For each outcome you will find one sample learning experience relating to the skills, concepts, and competencies for a specific indicator.

Guiding questions and learning experiences can be used to launch inquiry into the concept.

Indicators

- Investigate pure substances and mixtures in relation to particle theory (COM/PCD/CI/TF)
- Investigate methods of separation in solutions and mixtures (COM/CI/CT)
- **Analyse the factors that affect solubility and concentration (COM/CT/TF)**
- Measure the indicators of health of a local waterway with probeware (CZ/CI/TF)
- Analyse the health of a local waterway(CZ/COM/CI/CT)
- Investigate methods of water purification and pollution cleanup (CZ/COM/PCD/CI/CT)

Overview

The teacher presents learners with the task of designing an experiment t solubility and/or concentration. Depending on where learners are in th may provide questions in the form of a design challenge: How do you dissolve the most sugar in 100mL of water? What is the fastest method to dissolve a sugar cube?

This provides a quick description of the learning experience outlined in detail below.

Evidence of Learning for the indicator:

Analyse the factors that affect solubility and concentration

Evidence of learning can be gathered as learners design and conduct an e information about factors that affect solubility and concentration. Furth through conversations about the validity and reliability of the data learn

This section provides an overview of how assessment is embedded within the learning experience. The evidence of learning corresponds to the acquisition of skills and the understanding of concepts related to the outcome.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicat

Analyse the factors that affect solubility and concentration

This section details the steps for the sample learning experience and identifies the indicator in focus.

Potential Guiding Questions

- How do different variables affect solubility and concentration

Guiding questions that relate to the concepts of the sample learning experience are listed here to help launch student inquiry.

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Gather and select appropriate information

Learners can carry out their experiments and gather data. This may be done in small groups or pairs. Alternatively, learners may be placed into groups to discuss the various experimental designs and one design can be chosen to be conducted. Another option is to refine the experimental designs as a group to include elements from several members of the group into one design. This refined design can then be carried out. A discussion or mini lesson on how to effectively record data might help learners organize the experimental information that they will be gathering.

Along with the steps for the learning experience, competencies have been identified that best align with the steps as described.

Essential Graduation Competencies

Technological Fluency
This provides learners the opportunity to use technology in a re... and

A description of the competency that could be developed through this learning experience.

The teacher should provide feedback with respect to lab safety, throughout the experiment.

Evidence of Learning (Observations)

While students are collecting experimental data, the teacher can p... **gathering information** for analysis.

Evidence of learning is gathered throughout the learning experience. Suggested opportunities are found in these boxes.

Determining importance of information and Communicate Findings

Learners can share their findings by exploring the following questions:

- How do the results of different experiments compare?
- What do the results mean in relation to pollutants in the environment?
- How is the factor that you inquired about important for pollution management?

Essential Graduation Competencies

Communication
This provides learners the opportunity to listen and interact purposefully and respectfully in formal and informal contexts.

Evidence of Learning (Conversations)

Learners **communicate** and discuss the **importance of the findings**.

Evidence of Learning (Products)

Learners **communicate their findings** on the factors that affect solubility and concentration.

Moving Forward

How are the variables you investigated relevant to substances in the...

The next steps are scaffolded towards learner independence and application of the skill as it relates to the outcome

Outcome: Learners will analyse how the characteristics of cells relate to the needs of organisms.

Healthy Cells, Healthy Systems

Rationale

Studying the concepts of cell specialization and the structures needed for specialization leads to understanding how individual cells and systems are related. A comparison of various cell types will lead to an understanding of the survival needs of various organisms. Through the use of microscopes, learners will explore how advances in technology relate to new discoveries in science.

Competencies

- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Analyse the structures and functions of cells in organisms (COM/CI/CT)
- Compare animal and plant cells (COM/CT/TF)
- Analyse characteristics of specialized cells in relation to their function in the system (COM/PCD/CT/TF)
- Investigate how cells work together in systems (PCD/CT/TF)
- Investigate the needs of cells and systems (PCD/CT/TF)

Concepts (and Guiding Questions)

Interdependence of cell systems

- How do the needs of organisms relate to the needs of their cells?
- How do cells work together?
- How are cell and system function related?

Plant and Animal cells

- How can data collected from a microscope be represented?
- How do plant and animal cells compare?

Cellular Organelles

- How do cells meet the needs of plants?
- How do cells meet the needs of animals?

Cell specialization

- How do cell organelles and cellular structure relate to their specialized functions?
- Why don’t we digest our own stomach?

Skills

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives, communicate findings.

Compare

Make observations; identify similarities and differences; identify relationships and offer an interpretation; communicate the findings.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 6	Grade 8	Grade 9
Learners analysed how the body functions to meet its needs. This included concepts such as: basic structures and functions of body systems, how body systems are interconnected, ways to maintain health, ways the body protects itself and how vital signs can be measured.	Learners analysed the diversity of life in nature and gained an understanding of the various forms life can take and related this to the needs of living things.	Learners will analyse how the characteristics of cells relate to the needs of organisms. Learners will explore the following concepts: Interdependence of cells and systems, plant and animal cells, specialized cells, organelles	Learners will explore cellular processes including cellular reproduction.

Pollution provides the context for learning about particle theory in this outcome. Learners will explore the impact of various concentrations of substances in the environment. Learners are familiar with the concept of pollution and an understanding of particle theory will support their understanding of the scientific knowledge that underpins the concept of pollution. An understanding of solubility will help learners make decisions about what is safe or harmful for the environment.

Data logging sensors (probeware) can be used to collect data from local environments. This provides opportunities to connect with the mathematics curriculum as well as careers in environmental management. Using probeware allows for the collection of a lot of data in a short period of time so the effort can be placed in designing controlled experiments and analyzing the data for real-life implications. Learners have had probeware available to them as early as grade 4.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *analyse the structures and functions of cells in organisms by comparing animal and plant cells.*

Indicators

- Analyse the structures and functions of cells in organisms (COM/CI/CT)
- Compare animal and plant cells (COM/CT/TF)
- **Analyse characteristics of specialized cells in relation to their function in the system (COM/PCD/CT/TF)**
- Investigate how cells work together in systems (PCD/CT/TF)
- Investigate the needs of cells and systems (PCD/CT/TF)

Overview

Specialized cells have particular characteristics that allow them to perform specific functions for organs, systems and organisms. A simple analogy is that specialized cells have specific roles to carry out in systems. This learning experience is a project-based approach that exaggerates this analogy, positioning systems/organs as “employers” and specialized cells as “prospective employees”.

Evidence of Learning for the indicator:

Analyse characteristics of specialized cells in relation to their function in the system

For this indicator, evidence of learning can be collected as learners gather and select information about how specialized cells meet the needs of a system/organ and determine the accuracy of that information.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Analyse characteristics of specialized cells in relation to their function in the system

Potential Guiding Questions

- How do cell organelles and cellular structure relate to their specialized functions?
- How are cell and system function related?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Gather and select appropriate information

Learners imagine they are a cell applying for a job at a company (system and/or organ). The available jobs can be posted for them to view and decide which job they would like; for example the circulatory system might be looking for cells to compose the heart or the digestive system might be looking for cells to line the small intestine. These job postings can include basic information about the needs of the company and could be created by the learners as part of a separate learning experience.

Once learners have selected a job to apply for, they can explore the types of specialized cells that could potentially meet the needs outlined in the job posting. To support this research, learners might be prompted with the guiding questions provided above.

Essential Graduation Competencies

Personal-Career Development
This provides learners an opportunity to connect learning with personal and career development.

Evidence of Learning (Observations)

As learners **gather information** about specialized cells that are relevant to the needs of systems, observations can be made as to how they are selecting appropriate information.

Determine validity, and relevance of the information

Through their research, learners will have identified characteristics of a prospective employee (specialized cell). As cells have a variety of structures and functions, learners can be guided to then identify the characteristics that are most relevant for the specific employment opportunity. For example, mitochondria are important structures for heart muscle cells, large surface area is an important structural feature for cells lining the small intestine.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to synthesize information from relevant and reliable sources; analyse and evaluate evidence, arguments, and ideas.

Evidence of Learning (Conversations)

As learners **determine the validity and relevance of the information** they have gathered, discuss their strategy for prioritizing cellular structures and functions to meet the needs of their chosen system or organ.

Communicate Findings

Once learners have completed their research. they can share their findings with peers. Learners should be encouraged to communicate relationships between cell structures and functions, structures that are common in all cells, and those that are unique to specialized cells. They can be prompted to hypothesize how these cells might work together as organs and systems.
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Essential Graduation Competencies

Communication
This provides learners an opportunity to express and respond to ideas, information, learnings, perceptions, and feelings appropriate to audience and purpose through multiple media forms.

Evidence of Learning (Conversations)

As learners **communicate their findings** notice the types of structures that they are identifying as being common and/or specialized.

Moving Forward

Possible extension to this learning experience:

- Learners could create a resume from the perspective of the cell to respond to the job posting.

Question for further inquiry:

- How does cell specialization help an organism survive?
- What might happen if all the cells in our body had the same functions and structures?

Outcome: Learners will evaluate ways to maintain and factors that disrupt cell and system health.

Healthy Cells, Healthy Systems

Rationale

An evaluation of cell and system health provides an opportunity for learners to explore cell and body system disorders in depth through case studies. In learning about ways to maintain a healthy body, including related technologies and careers, learners will examine personally relevant contexts.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate disruptions and disorders that affect cell and system health (CI/CT/PCD/TF)
- Evaluate the impact of disruptions and disorders on cell/system health. (COM/PCD/CT/TF)
- Investigate technologies and careers that address cell/system health. (PCD/TF)
- Evaluate ways to maintain health from a number of perspectives, including Mi'kmaw (CZ/COM/PCD/CI/CT/TF)

Concepts (and Guiding Questions)

Cell/system disorders

- How do cells/systems "malfunction"?
- How can you determine the difference between a disorder and a disruption?
- How do health professionals use case studies to learn about cell and system disorders?

Maintaining Health

- How can we maintain cell and system health?
- How do Mi'kmaw perspectives enrich the understanding of maintaining health?

Health-related Technology

- How do technologies help us maintain cell/system health?
- How do technologies help us learn about cell/system health?

Skills

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 6	Grade 8	Grade 9
Learners analysed how the body functions to meet its needs. This included concepts such as: basic structures and functions of body systems, how body systems are interconnected, ways to maintain health, ways the body protects itself and how vital signs can be measured	Learners analysed the diversity of life in nature and gained an understanding of the various forms life can take and related this to the needs of living things.	Learners will evaluate ways to maintain and factors that disrupt cell and system health. Learners will explore the following concepts: cell/system disorders, maintaining health, health-related technology	Learners will explore the cellular processes of cell reproduction including mitosis and meiosis

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *evaluate the impact of disruptions and disorders on cell/system health while investigating disruptions and disorders that affect cell and system health*.

Indicators

- Investigate disruptions and disorders that affect cell and system health (CI/CT/PCD/TF)
- **Evaluate the impact of disruptions and disorders on cell/system health. (COM/PCD/CT/TF)**
- Investigate technologies and careers that address cell/system health. (PCD/TF)
- Evaluate ways to maintain health from a number of perspectives, including Mi'kmaw (CZ/COM/PCD/CI/CT/TF)

Overview

After investigating disorders that disrupt cell/system health, learners will evaluate the impacts of those disorders on cell and system health. A way to approach this outcome is through a case study methodology.

Evidence of Learning for the indicator:

Evaluate the impact of disruptions and disorders on cell/system health

For this indicator, teachers will gather evidence as learners prepare a case study of a cell or system disorder as a way to evaluate the impact of these disruptions.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Evaluate the impact of disruptions and disorders on cell/system health

Potential Guiding Questions

- How do health professionals use case studies to learn about cell and system disorders?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Review processes and results from an inquiry

Learners can prepare a case study of a fictional patient with a disorder that they have previously investigated.

Some suggestions might include:

- Asthma
- Broken bone
- Cancer
- Cystic Fibrosis
- Cold/flu
- Drug impairment
- Stroke

A reminder that disruptions and/or disorders may be acute or chronic and either of these types can be used in evaluating impact. Many learners may already have a personal connection to a disruption or disorder. This learning experience provides an opportunity for them to use personal interests to guide the identification and selection of a specific disruption/disorder.

Essential Graduation Competencies

Critical Thinking

This provides learners an opportunity to formulate decisions based on evidence; analyse and evaluate evidence, arguments, and ideas

This indicator is an opportunity to learn how to evaluate the impacts of disruptions/disorders on cell and system health. Case studies should focus on the impacts and demonstrate the connections between cell health and system health.

Case study components might include:

- Patient history
- Presenting symptoms
- Test results
- Treatment options
- Prognosis for the future

Personal-Career Development
This provides learners an opportunity to develop skills and practices to learn and work in diverse, evolving environments

Consider and communicate varying perspectives and alternative solutions or findings

The teacher may choose to divide learners into groups of specialists so that they can work as though they are part of a collaborative health team. Each learner can evaluate the impacts of the disruption/disorder using the perspective of a specialist to guide their approach. Alternatively, learners may choose to interview specialists and knowledgeable individuals as a way to gather information about the impacts of various disruptions or disorders. This information might also be gained through research.

Evidence of Learning (Conversations)

As learners **consider varying perspectives**, encourage them to **communicate these perspectives** with their classmates as a way of developing a fulsome conceptualization of the disorder/disruption at issue. The teacher can gather evidence as learners are making connections between the symptoms/result of the disruption and the cells/systems involved.

Identify potential new problems and/or issues; Justify decisions and/or findings:

Learners will have an opportunity to suggest decisions about treatment options for their fictional patient. These decisions should be justified, taking multiple perspectives and potential new issues into consideration by sharing the viewpoint of their specialty, and collaborating on a potential course of action.

Essential Graduation Competencies

Communication
This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal contexts; engage in constructive and critical dialogue

Technological Fluency
This provides learners an opportunity to implement technology effectively as appropriate to the learning experience

Evidence of Learning (Products)

Learners can share their **findings and final decisions, with justification**, in a pitch or presentation to the class or to others in a small group. Alternatively, sharing could occur in a world-cafe style or a gallery walk.

Moving Forward

What are some ways that interconnectiveness is being disrupted or changed near you or in your community? Question for further inquiry:

- How are cells and systems like social networks?
- What might happen if there is a disruption at a point in the network?

Outcome: Learners will create a model that demonstrates the principles of kinetic molecular theory

Climate Change

Rationale

In order to understand large scale concepts such as climate change, or small-scale concepts like kinetic molecular theory, it is often useful to produce models that demonstrate these concepts more concretely. The relationship between particle theory, heat transmission and absorption are best explored with hands-on application. This outcome extends the analysis of particle theory that began in grade 7. The focus in this theme is on the movement of particles and heat as it relates to climate change.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate heat as it relates to the kinetic molecular theory (CI/CT/TF)
- Evaluate conducting and insulating materials (COM/CT/TF)
- Investigate heat transference (CT/TF)
- Analyse heat absorption in the context of the greenhouse effect (CZ/COM/PCD/CT/TF)

Concepts (and Guiding Questions)

Kinetic Molecular Theory

- How does the kinetic molecular theory allow for an understanding of heat and temperature?
- How do the notions of hot and cold relate to the kinetic molecular theory?
- How does the kinetic molecular theory relate to states of matter?

Greenhouse effect and heat absorption

- How does the greenhouse effect work?
- How does kinetic molecular theory relate to the greenhouse effect?

Heat Transfer

- How does kinetic molecular theory relate to heat transfer?
- How does heat transfer impact our daily lives?

Heat Capacity of materials

- Why do some materials take longer to heat up/cool off?
- Which materials are best for insulating?

Skills

Create

Develop an idea; communicate a representation for a process and/or a product; produce a product; modify as necessary; evaluate results and/or modifications.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives, communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 7	Grade 8	Grade 9
Learners tested how physical and chemical changes affect the properties of matter. Concepts included physical and chemical properties of matter, physical and chemical changes as well as conservation of mass.	Learners analysed particle theory in relation to substances in environments. Concepts included: pure substances and mixtures, separation of mixtures, and solubility and concentration.	Learners will create a model that demonstrates the principles of kinetic molecular theory. Learners will explore the following concepts: Kinetic Molecular Theory, Greenhouse effect and heat absorption, Heat transfer, Heat capacity of materials.	Learners will explore atomic structure and periodic table properties.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *investigate heat as it relates to the kinetic molecular theory while evaluating conducting and insulating materials*.

Indicators

- Investigate heat as it relates to the kinetic molecular theory (CI/CT/TF)
- **Evaluate conducting and insulating materials (COM/CT/TF)**
- Investigate heat transference (CT/TF)
- Analyse heat absorption in the context of the greenhouse effect (CZ/COM/PCD/CT/TF)

Overview

An evaluation of conducting and insulating materials is one way to scaffold learning in relation to the outcome of creating a model that demonstrates the principles of kinetic molecular theory. By evaluating materials, learners will then be able to apply this understanding to model creation.

Evidence of Learning for the indicator:

Evaluate conducting and insulating materials

For this indicator, evidence of learning can be gathered as learners consider alternative solutions and findings and justify their decisions for the evaluation of conducting and insulating materials.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Evaluate conducting and insulating materials

Potential Guiding Questions

- Why do some materials take longer to heat up/cool off?
- Which materials are best for insulating?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Choice and flexibility are available while planning for this learning experience. Teachers can offer scenarios that will explore a selection of materials in response to a challenge.

Learners could:

- Build a simple solar cooker as a way to determine the conducting properties of various materials.
- Insulate a water bottle using found materials.
- Design a simulated space suit that must protect the wearer from solar radiation while being air tight.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to formulate decisions based on evidence; analyse and evaluate evidence, arguments, and ideas

This is an opportunity to use a temperature sensor so learners can see small changes in temperature as they occur. This will give learners opportunities to make refinements to their set-up, adjusting the materials used, and making design modifications in response to the data they record.

Learners might be prompted with the following questions:

- Which materials worked best for conducting/insulating?
- What evidence did you collect?
- How does your evidence support your design or modifications?
- What properties of the material allow it to act as an effective conductor/insulator?
- What additional factors that need to be considered when choosing a conducting/insulating material?

Consider and communicate varying perspectives and alternative solutions or findings; Justify decisions and/or findings:

After designing and testing in relation to their chosen scenario, learners will be asked to make a decision about which materials work best for conducting/insulating. In preparing their decision, learners should consider varying perspectives and factors. These might include cost or availability of materials and thus, feasibility of using the materials as conductors/insulators. Learners might engage in discussions about alternative solutions should a material be deemed too expensive or impossible as a solution. Following this consideration, learners can be prepared to justify their final decision using data collected during their inquiry. Learners could engage in these discussions in large or small groups. Learners might even pitch their ideas to an authentic audience and/or community members.

Technological Fluency
This provides learners an opportunity to implement technology effectively as appropriate to the learning experience; examine how technology and society impact and advance one another

Communication
This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal contexts; engage in constructive and critical dialogue

Evidence of Learning (Conversation)

As learners engage in a discussion about which materials are best for conducting heat and/or insulating, notice their **consideration of varying perspectives** and their use of **evidence to justify their decisions**.

Moving Forward

Question for further inquiry:

- Why do you feel colder when you're wet than when you're dry?

Outcome: Learners will evaluate oceanographic and other evidence of climate change inclusive of a Mi'kmaw perspective.

Climate Change

Rationale

The ocean is a primary source of evidence for measuring the health of our environment. The Mi'kmaw people have long used observational evidence to inform decision making. Evaluation of evidence for climate change will allow learners to make informed decisions about their role in climate change. Additionally, this evaluation will allow learners to discover career opportunities in ocean science and marine industry.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate the impact of climate change on biological organisms (CZ/COM/PCD/CT)
- Evaluate oceanographic data for evidence of climate change (COM/PCD/CI/CT/TF)
- Measure climatic indicators using probeware. (CT/TF)
- Analyse the impact of climate change on various communities, including Mi'kmaw. (CZ/COM/CT)

Concepts (and Guiding Questions)

Indicators of Climate Change

- How can evidence be used to determine that the earth's climate is changing?
- How can we measure climate change?
- How can ocean careers contribute to a better understanding of climate change?

Community impacts

- How has climate change affected various communities?
- How will climate change affect communities in the future?

Biological Impacts

- How does climate change impact various living organisms?
- How do organisms respond to climate change?

Oceanographic Evidence

- How does climate change affect oceans?
- How can oceanographic data be used to determine changes to earth's climate?
- How does climate change impact coastlines?

Skills

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives, communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 7	Grade 8	Grade 10
Learners investigated how weather impacts daily life, including weather conditions that affect living and non-living things, and the significance of seasonal cycles and events.	Learners implemented an environmental stewardship plan. Additionally, learners analysed factors that affect coastline change.	Learners will evaluate oceanographic and other evidence of climate change, inclusive of a Mi'kmaw perspective. Learners will explore the following concepts: indicators of climate change, community impacts, biological impacts, oceanographic evidence.	Learners will explore ecosystems and succession following ecosystem disruptions. Learners will also analyse weather data and explore weather dynamics.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *evaluate oceanographic data for evidence of climate change by investigating the impact of climate change on biological organisms.*

Indicators

- **Investigate the impact of climate change on biological organisms (CZ/COM/PCD/CT)**
- Evaluate oceanographic data for evidence of climate change (COM/PCD/CI/CT/TF)
- Measure climatic indicators using probeware. (CT/TF)
- Analyse the impact of climate change on various communities, including Mi'kmaw. (CZ/COM/CT)

Overview

An investigation of the impact of climate change on biological organisms can take many forms. Learners may choose a specific biological organism to focus on. Suggestions include: black legged deer ticks, migration of whales, corals, plankton, distribution of coniferous trees, etc.

Evidence of Learning for the indicator:

Investigate the impact of climate change on biological organisms

For this indicator, teachers can gather evidence as learners develop questions for inquiry, select information to support and answer, and communicate their findings about the impact of climate change on biological organisms.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Investigate the impact of climate change on biological organisms

Potential Guiding Questions

- How does climate change impact various living organisms?
- How do organisms respond to climate change?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Ask and revise questions

Investigations begin by asking and revising questions about the topic being investigated. Learners may benefit from a mini lesson on open versus closed questions to help them arrive at questions that can sustain a thorough investigation. Starting with the potential guiding questions as points for discussion, learners can generate questions that could be asked to find out more about the impact of climate change on biological organisms. It is suggested that learners construct criteria relating to what makes a good question. They can then share questions with their classmates, giving and receiving feedback in relation to their criteria.

Essential Graduation Competencies

Communication

This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal contexts; engage in constructive and critical dialogue

Evidence of Learning (Conversations)

As learners **ask and revise questions** by sharing their questions with their classmates, ensure that the questions are open-ended and suitable for inquiry.

Locate several relevant and dependable details to support an answer

Details to support an answer can be found in various ways. Learners might set up a model to explore the impacts of an aspect of climate change. They might model migration changes or habitable zones based on temperature changes. Alternatively, learners might set up an experiment that models an aspect of climate change.

For example, learners can engage in a laboratory experiment involving the impacts of acidification on calcium structures such as those that compose the exoskeletons of crustaceans and corals in order to locate details. Learners can use a straw to bubble CO_2 that comes from their exhaled breath into water containing calcium. Chalk or diatomaceous earth can act as a model for underwater calcium structures. An alteration to this setup can be to offer learners an opportunity to create a system to release CO_2 into their model through its capture from a yeast and sugar water solution or sodium bicarbonate solution mixed with a weak acid. As learners engage in their experiment, they can select evidence by massing the calcium before and after exposure to carbonic acid giving an indication of the effects on living organisms with calcium structures and recording observations, during, and after exposure to increased CO_2. Diatomaceous earth might also be viewed under the microscope before and after exposure to carbonic acid.

As learners move on to organize and compare details from this lab, they may come to know new information like:

- Increased atmospheric CO_2 will lead to more CO_2 being dissolved in bodies of water.
- CO2 interacts with water, leading to acidification in the form of carbonic acid

This experiment investigates one aspect of the impact of climate change on biological organisms, but some learner-generated questions may not lend themselves to experimental inquiry or model-building. In these cases, learners can conduct research to

Essential Graduation Competencies

Citizenship
This provides learners an opportunity to develop skills and practices that support environmental sustainability

Communication
This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal contexts; engage in constructive and critical dialogue

Critical Thinking
This provides learners an opportunity to formulate decisions based on evidence; analyse and evaluate evidence, arguments, and ideas

Personal-Career Development
This provides learners an opportunity to develop skills and practices to learn and work in diverse, evolving environments; connect learning with personal and career development.

locate details to support an answer. This research might take many forms, including interviewing experts, community members, and Elders. Following this, learners can communicate their findings in a manner appropriate to their method of investigation and intended audience

Evidence of Learning (Conversations)

Learners can produce research evidence, interview notes, data tables, graphs, etc., showing the results of their experiment or model as a way to **locate and organize details and to support an answer** that identifies a relationship between climate change and biological organisms.

Moving Forward

Question for further inquiry:

- What climate change impacts are evident near you or in your community?

Outcome: Learners will evaluate the impact of human activity on climate change.

Climate Change

Rationale

The increase of carbon in the atmosphere is the reason climate change is happening and much of that carbon comes from energy production. By studying both renewable and non-renewable energies, learners will be able to evaluate the positive and negative impacts of human activity on the environment.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Critical Thinking (CT)
- Technological Fluency (TF)

Indicators

- Analyse the causes of climate change (CZ/COM/CT/TF)
- Evaluate the environmental impacts of various sources of energy (CZ/COM/CT/TF)
- Analyse how climate change is being expedited (CZ/COM/CT/TF)

Concepts (and Guiding Questions)

Causes of climate change

- How are human activities linked to climate change?
- How is the impact of humans on climate change measured?

Sources of energy

- How do we get energy?
- How can the environmental impacts of various forms of energy production be determined?

Enhanced Greenhouse Effect

- How do humans impact the greenhouse effect?
- How is energy production related to climate change?

Skills

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives, communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 6	Grade 7	Grade 8	Grade 9
Learners explored the impact energy consumption has on resources used to generate electricity. They investigated energy transformations and compared renewable and non-renewable sources. Learners also explored how personal actions can lead to reducing electrical energy consumption.	Learners implemented an environmental stewardship plan. They also analysed the impact of humans on ecosystems in relation to the concepts of Netukulimk and sustainability.	Learners will evaluate the impact of human activity on climate change. Learners will explore the following concepts: causes of climate change, sources of energy, enhanced greenhouse effect.	Learners will explore sources of renewable and alternative energy. Learners will examine the relationship between science, technology and the environment.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *evaluate the environmental impacts of various sources of energy while analysing how climate change is being expedited.*

Indicators

- Analyse the causes of climate change (CZ/COM/CT/TF)
- Evaluate the environmental impacts of various sources of energy (CZ/COM/CT/TF)
- **Analyse how climate change is being expedited (CZ/COM/CT/TF)**

Overview

In this learning experience, learners will have an opportunity to analyse graphs showing greenhouse gas emissions and their sources in Canada and more specifically, in Nova Scotia.

Evidence of Learning for the indicator:

Analyse how climate change is being expedited

Evidence of learning can be gathered through observations of learners' strategies for determining the accuracy, validity and relevance of research sources. Further evidence can be collected as learners use data from emissions graphs to draw conclusions about human impacts on climate change.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Analyse how climate change is being expedited

Potential Guiding Questions

- How do humans impact the greenhouse effect?
- How is the impact of humans on climate change measured?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Gather and select appropriate information

Learners may be encouraged to search for graphs showing current and past greenhouse gas emissions for Canada and Nova Scotia, broken down by origin from a reputable source such as Environment Canada or Statistics Canada. If locating their own graphs, provide support to ensure learners have appropriate tools to allow them to **determine accuracy, validity, and relevance** of the source and the information presented. This could be graphic organizers for students to corroborate data between sources, or to assess the validity of websites.

Learners should also be prepared to **identify perspectives** that may be biased depending on the source of the data. Alternatively, the graphs could be sourced and prepared in advance by the teacher.

Essential Graduation Competencies

Communication
This provides learners an opportunity to analyse the impact of information communication technology in relation to social issue

Evidence of Learning (Conversation)

The teacher can engage in conversations with learners to understand their process for gathering information and assessing sources for **accuracy, validity and relevance**.

Evidence of Learning (Product)

Teachers can gather evidence from the learners' graphic organizers and provide feedback on the information gathered and the assessment of sources.

Prior to having learners work in small groups or with a partner, the teacher can have a mini lesson to ensure learners understand what the graphs show. Learners can identify the key components of the graph depending on the type of graph they are reading (for example, locate and identify the variables represented by the x and y axis in a line graph, describe the discrete variables included in the legend for a bar graph or pie chart, review the meaning of percentages, etc.) Learners can have opportunities to examine their graphs and note how they compare. For example, the scale of their two graphs may or may not be the same; this means direct visual comparisons of the graphs might be challenging.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to analyse and evaluate evidence, arguments, and ideas

Evidence of Learning (Observation)

While learners discuss and compare their graphs, the teacher can gather evidence from the details they are discussing.

After viewing the graphs and discussing their observations with a partner, learners can be invited to participate in generating a class list of questions that might be answered using the information displayed in the graphs. Additionally, the class can record any additional questions that arise that cannot be answered by the graphs they are using. These new questions may lead to an extension of this learning experience and further investigations.

Essential Graduation Competencies

Communication
This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal contexts; engage in constructive and critical dialogue

Questions may include, but would not be limited to:

- What is the most significant source of greenhouse gas emissions in Canada?
- How does this compare with Nova Scotia emissions for the same source?
- How do you think it compares with other provinces and territories?
- Which sources shown in the graphs release methane gas?
- Which source(s) displayed on the graphs would be impacted if humans reduced their use of electricity (assuming electricity is generated by burning fossil fuels)?
- If everyone recycled more, which source of emissions would be affected?
- Which source(s) of emissions would be reduced if there was increased use of public transportation and/or cycling?

Evidence of Learning (Conversation)

Evidence of learning can be gathered as a class list of questions is curated. It may be helpful to provide time for individuals to record their own ideas first and share with a partner before creating a class list.

Communicate findings

Once the list of questions has been curated, learners could work together in small groups to search for the answers to one, several, or all of the questions. Additionally, each group could select a second province or territory in addition to Nova Scotia to compare their provincial results. This is an opportunity for learners to consider an aspect of the citizenship competency: **practices that support environmental sustainability** in relation to human impacts on climate change.

Essential Graduation Competencies

Technological Fluency
This provides learners an opportunity to examine how technology and society impact and advance one another

Evidence of Learning (Product)

The information gathered from the analysis of graphs and additional research could be shared as a short presentation in a format of the learner's choice to **communicate their findings**.

Evidence of Learning (Conversation)

Encourage a class discussion to highlight similarities and differences in their **findings**.

Moving Forward

- Have you noticed the energy sources used in your community changing?
- Why do you think they are/are not changing?

Outcome: Learners will formulate a plan to mitigate or adapt to the effects of climate change.

Climate Change

Rationale

This outcome is the consolidation and application of the other outcomes within this theme. Formulating a plan to mitigate or adapt to climate change will allow learners to apply what they have learned about heat energy, human impact and climate-based careers in an authentic way. Evaluating the climate change plans of others will provide opportunities for learners to explore possible implications of their actions.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate strategies to promote paradigm shift and increase environmental awareness
- Investigate climate change solutions inclusive of a Mi'kmaw perspective (CZ/CI/CT)
- Evaluate the environmental impact of green technologies (CZ/COM/PCD/CT/TF)
- Evaluate the implications of potential climate change solutions (CZ/COM/PCD/CI/CT)

Concepts (and Guiding Questions)

Climate change solutions

- How will humans need to change the way they live in response to changing climate?
- How do certain careers help to mitigate or adapt to the effects of climate change?

Environmental Paradigm shift

- How is environmental awareness changing?
- How can we as individuals impact perceptions of environmental issues?

Green Technology

- How can technology help us adapt to a changing climate?
- How can climate change solutions pose other problems?

Skills

Formulate

Identify a topic of interest; brainstorm ideas; choose, prioritize, and refine ideas; evaluate choices.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 7	Grade 8	Grade 10
Learners investigated how weather impacts daily life, including weather conditions that affect living and non-living things, and the significance of seasonal cycles and events.	Learners implemented an environmental stewardship plan. Additionally, learners analysed factors that affect coastline change.	Learners will formulate a plan to mitigate or adapt to the effects of climate change. Learners will explore the following concepts: climate change solutions, environmental paradigm shift, green technology.	Learners will explore ecosystems and succession following ecosystem disruptions as well as shifting environmental philosophies. Learners will also analyse weather data and explore weather dynamics.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *evaluate the implications of potential climate change solutions by investigating climate change solutions inclusive of a Mi'kmaw perspective*.

Indicators

- Investigate strategies to promote paradigm shift and increase environmental awareness
- Investigate climate change solutions inclusive of a Mi'kmaw perspective (CZ/CI/CT)
- Evaluate the environmental impact of green technologies (CZ/COM/PCD/CT/TF)
- **Evaluate the implications of potential climate change solutions (CZ/COM/PCD/CI/CT)**

Overview

As part of the formulation of a plan to mitigate or adapt to climate change, learners will explore various existing climate change solutions. It is important to evaluate the implications of these potential solutions to be aware of potential unintended consequences and alternative perspectives.

Potential solutions that learners might evaluate are: various renewable and alternative energy sources (wind, solar, nuclear, tidal, wave), changes to diet (reducing meat consumption, alternate food sources such as crickets and manufactured meat), transportation alternatives (E-vehicles, mass transit, ride sharing, carbon offsets for flights), planting trees, carbon recapture, new construction technologies, etc...

Evidence of Learning for the indicator:

Evaluate the implications of potential climate change solutions

Evidence of learning can be gathered as learners develop interview questions on the potential implications of climate change solutions. Further evidence can be communicated as learners consider a variety of perspectives in their findings.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Evaluate the implications of potential climate change solutions

Potential Guiding Questions

- How will humans need to change the way they live in response to changing climate?
- How is environmental awareness changing?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Consider and communicate varying perspectives and alternative solutions or findings

As part of evaluating the implications of potential climate change solutions, learners will consider varying perspectives and alternative solutions. One way to gather varying perspectives is to conduct interviews with various people. This can be done in pairs or small groups. Learners can interview community members, Elders, youth, workers in different industries, etc.

Essential Graduation Competencies

Communication
This provides learners an opportunity to listen and interact purposefully and respectfully in formal and informal context

Learners can work in pairs or small groups to come up with questions to ask during their interviews. However, depending on where learners are in their skill development, the teacher may provide sample questions such as the following:

- What do you know about this strategy?
- How did you learn about it?
- What do you think about this strategy?
- Would you be open to having this strategy employed in your community or neighbourhood? Why or why not?
- What do you think is important in a strategy to mitigate or adapt to climate change?
- Have you always felt the same about this or have you changed perspectives?

Evidence of Learning (Conversations)

Learners will develop questions to ask community members and others as a way of **considering and communicating varying perspectives**.

Learners can also conduct research into how the various mitigation and adaptation strategies work and may then make informed inferences about alternate perspectives and solutions. Provide opportunities for learners to gain perspectives from others by setting up sharing opportunities. These can take the format of student expert tables or gallery walks or informal sharing following the interviews or research phases. Learners can also collaborate and share their own opinions and viewpoints that are supported by evidence (anecdotal, experiential or other).

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to recognize that experiences shape perspectives

Evidence of Learning (Conversations)

Learners **consider varying perspectives** as they share their research and interview findings with one another.

Evidence of Learning (Observations)

Evidence can be gathered as learners engage in constructive and critical dialogue to **communicate varying perspectives**.

Moving Forward

Following this, learners can use what they have gathered with respect to varying perspectives to decide upon alternate solutions and potential new problems.

An additional idea would be to examine society's changing perceptions about climate change through examining media advertisements from a variety of time periods related to the environment.

Question for further inquiry

- How can media be used as an indicator of societal values and change with respect to environmental issues?

Outcome: Learners will test the effects of changes in temperature and pressure on the properties of fluids.

Hydraulics and Pneumatic Systems

Rationale

The properties of fluids should be explored by developing procedures for testing, a significant step in understanding the importance of controlling variables. To best understand fluid dynamics, learners should also test factors that affect fluid properties in a hands-on way. This approach is particularly useful for investigating viscosity which is a new concept to most learners.

Competencies

- Communication (COM)
- Critical Thinking (CT)
- Technological Fluency (TF)

Indicators

- Investigate the properties of fluids (CT/TF)
- Test factors that affect fluid properties (CT, CI, COMM)
- Analyse the relationships between temperature, volume, pressure, compressibility, viscosity, and density (COM/CT/TF)
- Measure temperature and pressure with probeware (TF)

Concepts (and Guiding Questions)

Properties of Fluids

- How is air a fluid?
- How do the properties of viscosity, density, compressibility and pressure relate?

Factors that affect fluid properties

- How can the relationship between temperature and pressure be tested?
- How can the viscosity of a fluid be changed?

Experimental Design

- How can variables be controlled when conducting a test?
- How does a graphical representation assist in the analysis of data?

Skills

Test

Formulate a testable question and a reasonable hypothesis; identify dependent and independent variables; identify variables to intentionally control; design an experiment; execute the steps; collect and record evidence; conduct data analysis; develop conclusions based on evidence; communicate findings and possible limitations.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Analyse

Gather and select appropriate information; determine accuracy, validity, and relevance of the information; identify perspectives, communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 2	Grade 5	Grade 8	Grade 11
Learners investigated liquids, solids and mixtures while exploring the following concepts: states of matter, properties of liquids and solids, dissolving and non dissolving.	Learners tested how physical and chemical changes affect the properties of matter. This included an investigation of the conservation of mass in simple physical and chemical changes.	Learners will test the effects of changes in temperature and pressure on the properties of fluids. Learners will explore the following concepts: properties of fluids, factors that affect fluid properties, experimental design.	Learners explore fundamental properties of waves, including sound waves.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *analyse the relationships between temperature, volume, pressure, compressibility, viscosity, and density* by *testing factors that affect fluid properties*.

Indicators

- Investigate the properties of fluids (CT/TF)
- **Test factors that affect fluid properties (CT, CI, COM)**
- Analyse the relationships between temperature, volume, pressure, compressibility, viscosity, and density (COM/CT/TF)
- Measure temperature and pressure with probeware (TF)

Overview

Though the selected indicator for this experience will have learners *test factors that affect fluid properties*, the description below outlines only the design portion of the skill. The actual testing and data analysis portion of the skill will be dependent on learners' specific designs.

With that in mind, teachers may provide a challenge as a starting point for inquiry. For example, learners might be challenged to decrease the viscosity of molasses or to increase the viscosity of heavy cream.

Evidence of Learning for the indicator:

Test factors that affect fluid properties

Evidence of learning can be gathered as learners communicate their testable questions and hypotheses. Further evidence can be observed during the development and modification of the design.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Test factors that affect fluid properties

Potential Guiding Questions

- How can the viscosity of a fluid be changed?
- How can variables be controlled when conducting a test?
- How does a graphical representation assist in the analysis of data?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Introduction

This indicator might follow an investigation of the properties of fluids where learners explored viscosity of various fluids. As part of that investigation, it is helpful to demonstrate a method for investigating viscosity such as measuring rate of flow through a funnel or along a metal sheet or board. Learners can begin their test of factors that affect fluid properties with a challenge. Learners can be challenged to change the viscosity of a fluid that they investigated previously. In order to accomplish this, learners will come to know the factors that affect this property. For example, learners might be challenged to decrease the viscosity of molasses or to increase the viscosity of heavy cream.

Note: Learners will test various factors that affect properties of fluids. Viscosity is used here simply as one example.

Formulate a testable question and a reasonable hypothesis, Identify dependent and independent variables

Once learners have decided on a challenge that they would like to undertake, they should formulate a testable question and a reasonable hypothesis. The testable question should include both an independent and a dependent variable. Learners may need support in creating a question that tests only one independent variable at a time. They may also need support in defining a dependent variable to measure. In order to formulate a reasonable hypothesis, learners may need to conduct some research on the variables that they have chosen.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to formulate decisions based on evidence; analyse and evaluate evidence, arguments, and ideas.

Evidence of Learning (Conversations)

As learners **formulate their testable question and a reasonable hypothesis**, feedback can be provided about the variables that they are using and the justification behind their hypothesis.

Identify variables to intentionally control

Once learners have identified the independent and dependent variables, they should identify all of the variables that need to be controlled for their experiment. These variables should be ones that might reasonably impact the dependent variable rather than obscure variables that are unrelated to the experiment. Learners may benefit from small or large group discussions about control of variables where learners can share their ideas.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to analyse information and evidence, suspending judgement and accepting ambiguity

Evidence of Learning (Conversations)

As learners are discussing their ideas for **intentionally controlling variables**, feedback can be provided to ensure relevant controlled variables are identified.

Design an experiment

Learners should design an experiment that clearly outlines the materials that they need as well as any safety considerations that are relevant. Experimental designs should clearly indicate variables, including how the variables will be measured and/or controlled. Learners can devise a design for how they will record their data and observations. This may take the form of preparing their data tables and or diagrams. The experimental design should be reviewed with the teacher prior to conducting the experiment.

Essential Graduation Competencies

Creativity and Innovation
This provides learners an opportunity to use constructive feedback to reflect on creative and innovative works and processes

The teacher may wish to provide limitations on the materials that are available to learners as a way of helping them focus on factors that will have the most direct impact on viscosity. Learners may also benefit from guidance about the number of trials they should undertake in order to have robust data.

It is encouraged to allow learners to take responsible risks here as non-results in an experiment also contribute to learning. However, it is best for learners to be set up for success and there are various ways that teachers can facilitate this. One way is to have learners provide feedback on each other's experimental designs prior to conducting the experiments.

Essential Graduation Competencies

Communication
This provides learners an opportunity to engage in constructive and critical dialogue.

Evidence of Learning (Product)

Learners will provide evidence of their **experimental design**. These should be reviewed for safety and the capacity for learners to execute the steps.

Evidence of Learning (Conversations/Observations)

Evidence of learning can be gathered as learners describe their experimental designs and provide peer feedback on the designs.

Moving Forward

Learners can follow this up by executing the steps of their experimental design followed by the remaining components of the Test skill.

Further inquiry:

- How does your knowledge about fluid properties help you better understand the workings of hydraulic and pneumatic systems?

Outcome: Learners will compare mechanical advantages provided by hydraulic and pneumatic systems.

Hydraulics and Pneumatics Systems

Rationale

To understand how hydraulic and pneumatic systems create mechanical advantage, learners need to understand the properties of compressibility and force and how these forces are transferred. Learning how and where hydraulic and pneumatic systems are used is also important in giving authentic context to the learner.

Competencies

- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate devices that use hydraulics and pneumatics (PCD/CI/TF)
- Compare hydraulic and pneumatic systems (COM/CT/TF)
- Investigate how mechanical advantage is created in hydraulic and pneumatic devices (CI/CT/ TF)

Concepts (and Guiding Questions)

Hydraulic and pneumatic devices

- How are hydraulics and pneumatics used in various tools and technologies?
- How are hydraulics and pneumatics applied to innovations made locally and globally?

Hydraulic and pneumatic systems

- How do hydraulic and pneumatic systems compare?
- How can pressure be used to accomplish tasks?
- How are hydraulics and pneumatics used in various careers?

Mechanical Advantage

- How do hydraulic and pneumatic systems provide mechanical advantage?
- How can the mechanical advantage generated by hydraulic/pneumatic systems be modified?
- How does surface area and/or size of tubing affect mechanical advantage?

Skills

Compare

Make observations; identify similarities and differences; identify relationships and offer an interpretation; communicate the findings.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 7	Grade 8	Grade 11
Learners will have constructed effective simple and compound machines. In doing so, they investigated forces in simple machines and tested machines for effectiveness.	Learners tested various forces affecting structures and explored concepts such as internal and external forces, static and dynamic forces, loading and balanced and unbalanced forces.	Learners will compare the mechanical advantage provided by hydraulic and pneumatic systems. Learners will explore the following concepts: hydraulic and pneumatic devices, hydraulic and pneumatic systems, mechanical advantage.	Learners will explore motion and use vectors to represent forces and analyse work, power and efficiency in physics 11. Additionally, learners will explore conservation of energy and momentum.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *compare hydraulic and pneumatic systems* while *investigating how mechanical advantage is created in hydraulic and pneumatic devices*.

Indicators

- Investigate devices that use hydraulics and pneumatics (PCD/CI/TF)
- Compare hydraulic and pneumatic systems (COM/CT/TF)
- **Investigate how mechanical advantage is created in hydraulic and pneumatic devices (CI/CT/TF)**

Overview

Learners investigate various systems of tubing and syringes in order to observe and identify the relationship between tubing/syringe size on mechanical advantage

Evidence of Learning for the indicator:

Investigate how mechanical advantage is created in hydraulic and pneumatic devices

Evidence of learning can be gathered as learners explore tubing and syringe sizes and identify relationships to mechanical advantage.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Investigate how mechanical advantage is created in hydraulic and pneumatic devices

Potential Guiding Questions

- How does surface area and/or size of tubing affect mechanical advantage?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Introduction:

Learners can be engaged in an introduction to mechanical advantage by setting up a scenario using syringes of various sizes connected to each other with tubing. The teacher might create several syringe/tubing systems such as: connecting a small syringe to a large one with tubing, connecting two syringes of the same size, connecting a medium sized syringe to a large one etc. The syringes and tubing should be filled with water since it is less compressible than air which allows for more direct observation of the effect of pressing on the syringes in the system.

Learners can be prompted to investigate these systems while guided by a question such as the one proposed above. This can be done in pairs or small groups. Individual explanations might be challenging because of the set-up of the syringe systems.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to analyse and evaluate evidence, arguments, and ideas

Locate several relevant and dependable details to support an answer

Using the guiding question, learners can devise strategies to collect information about the relationship between surface area and/or size of tubing. A potential way of initiating these observations may be to challenge learners to use the least amount of force possible to move a syringe. By asking questions and manipulating the various tubing systems, learners can gather data to support an answer to the guiding question.

Essential Graduation Competencies

Creativity and Innovation
This provides learners an opportunity to use constructive feedback, reflect, and learn from trial and error

Learners may need support in setting up a fair test where they are manipulating only one independent variable at a time like syringe size or tubing size, while collecting their data. Learners may benefit from suggestions on the types of data to collect to determine mechanical advantage. This data might be anecdotal, it might involve a spring scale, a pressure or force sensor, or it might involve using the syringe to move a heavy object or objects of different masses.

Evidence of Learning (Observations)

While learners are **locating several relevant and dependable details to support their answer**, observe their methodologies and provide feedback on conducting fair tests.

Organize and compare details

As learners gather data to support an answer, they can record this data in a way that can be easily interpreted by others and that allows for comparisons between the mechanical advantage provided by the various systems. Data can be presented in a table, a graph, using drawings etc… Learners might benefit from assistance in setting up a graph so that their independent variable(s) appears on the x-axis and the dependent variable appears on the y-axis.

Essential Graduation Competencies

Technological Fluency
This provides learners an opportunity to implement technology effectively as appropriate to the learning experience.

Evidence of Learning (Products)

Learners record evidence of their observations. The teacher can provide feedback on how the evidence can be **organized** in a way that allows for the **comparison of details**.

Identify relationships, recognize represented perspectives, communicate findings

Learners can use their data to identify the relationship between syringe/tubing size and mechanical advantage. Encouraging groups to communicate their findings with each other, allows for recognition of multiple perspectives.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to formulate decisions based on evidence.

Questions that might be used to prompt this discussion could be:

- What is the relationship between surface area and/or size of tubing and mechanical advantage?
- What evidence do you have to support your findings? (How do you know?)
- Did all groups use the same independent variables?
- Did all groups measure the same dependent variables?
- Are there groups who collected similar findings?
- Are there differences between the findings of your group and other groups?
- Do you have ideas about how you might explain these differences?

Evidence of Learning (Conversations)

As learners engage in conversations and discussions about **relationships and perspectives**, evidence of learning can be gathered about strategies for using their data to support the discussion and **communicate their findings**.

Moving Forward

- How does the model you used in this learning experience compare to a working hydraulic or pneumatic system?
- What are the advantages of using models to learn about complex systems? What are the disadvantages?

Outcome: Learners will construct a device that utilizes hydraulics or pneumatics.

Hydraulics and Pneumatics Systems

Rationale

This outcome is the consolidation and application of the other outcomes within this theme. Constructing a hydraulic or pneumatic device will allow learners to apply what they have learned about the properties of fluids and mechanical advantage in an authentic way. Evaluating the efficiency and effectiveness of devices constructed by others will provide learners with an opportunity to iterate their designs.

Competencies

- Citizenship (CZ)
- Communication (COM)
- Creativity and Innovation (CI)
- Critical Thinking (CT)
- Personal Career Development (PCD)
- Technological Fluency (TF)

Indicators

- Investigate problems that may be solved with hydraulics or pneumatics. (CI/CT/PCD/TF)
- Apply the properties of fluids in building a device (CI/TF)
- Evaluate devices for efficiency and effectiveness (COM/PCD/CT/TF)
- Implement a design for a hydraulic or pneumatic device (CI/CT/TF)

Concepts (and Guiding Questions)

Applications of hydraulics and pneumatics

- How can I solve a problem using hydraulics and pneumatics?
- In what situations would I choose a hydraulic system? A pneumatic system?

Applying the properties of fluids

- How can our knowledge of properties of fluids help us in the construction of a hydraulic or a pneumatic device?
- How do hot and cold temperatures affect the functioning of my device?

Efficiency and effectiveness

- How can I determine the efficiency of my device?
- How can devices be altered to improve their effectiveness?

Skills

Construct

Identify a purpose; brainstorm ideas; gather and select information to support a plan; identify and choose options within the plan; offer reasons to support choices; build a model; test and revise, modify as necessary; evaluate the results at each stage of the process; consider alternative options.

Investigate

Ask and revise questions; locate several relevant and dependable details to support an answer; organize and compare details; identify relationships, recognize represented perspectives and communicate findings.

Apply

Carry out, use or complete a procedure/ technique.

Evaluate

Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Implement

Select - Locate several relevant and dependable details to support an answer

Plan – FORMULATE Identify a topic of interest; brainstorm ideas; choose, prioritize, and refine ideas; evaluate choices. Devise a process to solve the problem. Execute the steps, modifying as necessary.

Evaluate - Review processes and results from an inquiry; consider and communicate varying perspectives and alternative solutions; identify potential new problems and/or issues; justify decisions and/or findings.

Apply - Carry out, use or complete a procedure/ technique.

Background Knowledge

The following chart provides an alignment of related concepts between grade levels:

Grade 5	Grade 7	Grade 8	Grade 11
Learners will have constructed effective simple and compound machines. In doing so, they investigated forces in simple machines and tested machines for effectiveness.	Learners tested various forces affecting structures and explored concepts such as internal and external forces, static and dynamic forces, loading and balanced and unbalanced forces.	Learners will construct a device that utilizes hydraulics or pneumatics. Learners will explore the following concepts: hydraulic and pneumatic devices, hydraulic and pneumatic systems, mechanical advantage.	Learners will explore motion and use vectors to represent forces and analyse work, power and efficiency in physics 11. Additionally, learners will explore conservation of energy and momentum.

Learning Experiences

The suggested indicators are organized in a way to scaffold learning in support of the outcome. The exploration of skills and concepts for this outcome can be done in any order, concurrently, or selectively based on the progression of learning. The experience described below is presented independently from the other indicators that support the outcome, however, in practice multiple indicators can be addressed simultaneously. For example, learners may *apply the properties of fluids in building a device* while *implementing a design for a hydraulic or pneumatic device*.

Indicators

- Investigate problems that may be solved with hydraulics or pneumatics. (CI/CT/PCD/TF)
- Apply the properties of fluids in building a device (CI/TF)
- Evaluate devices for efficiency and effectiveness (COM/PCD/CT/TF)
- **Implement a design for a hydraulic or pneumatic device (CI/CT/TF)**

Overview

This indicator would be a final step towards the outcome of constructing a device. The type of device to be constructed should be responsive to learners' interests. For that reason, an outline for a specific device is not included in this learning experience. Instead, the example below provides suggestions of how teachers can guide skill development by focussing on the *planning* and *evaluation* of learners' designs.

Evidence of Learning for the indicator:

Implement a design for a hydraulic or pneumatic device

Evidence of learning can be gathered as learners engage in discussions to refine their ideas and devise a process to solve a problem.

The evidence found through the learning experience for this indicator are suggestions of what teachers can look for in relation to skills and concepts. Regardless of the methods used, it is necessary for teachers to be intentional about collecting evidence of student learning to inform next steps for teaching.

Description of learning experience for the indicator

Implement a design for a hydraulic or pneumatic device

Potential Guiding Questions

- What real-world problems could be mitigated using hydraulics and/or pneumatics?
- How can you plan and execute a working model that uses hydraulics and/or pneumatics to mitigate a real-world problem?
- What parts of your plan were executed successfully?

*The learning experience below is **one possibility** to engage learners with **this indicator**. It will be necessary to modify this experience to engage learners in a culturally and linguistically responsive way.*

Prior to this learning experience, learners would have identified a real-world problem and a device they will design and construct to solve that problem. In some situations, it may be helpful to develop an interdisciplinary project connecting this outcome and indicator with Grade 8 Technology Education outcomes. In any case, learners can be provided with some choice to ensure the learning experience is engaging and meaningful to them.

Suggestions for real-world applications of hydraulics and/or pneumatics used to mitigate problems might include:

- a moving miniature billboard sign
- a toy dump truck
- or a door opener.

Essential Graduation Competencies

Technological Fluency
This provides learners an opportunity to examine how technology and society impact and advance one another.

Regardless of the project selected, learners will devise a process to solve the problem, execute the steps and modify their model as necessary. To focus the learners' attention on skill development and competency exploration throughout this process, intentional mini lessons to highlight examples of how to use constructive feedback, reflect, and learn from trial and error can be included in the project timeline.

Essential Graduation Competencies

Creativity and Innovation
This provides learners an opportunity to use constructive feedback, reflect, and learn from trial and error

Evidence of Learning (Products)

Learners might communicate their design and plan through a sketch or blueprint. Teachers can provide feedback on both the design and the process learners devised.

Evidence of Learning (Conversations)

As learners **execute the steps** of their plan, the teacher can prompt the learners to consider potential **modifications** and/or improvements they might make..

While learners are reviewing alternative solutions and trying different strategies to plan, construct, and refine their models, the following questions might prompt reflection or provide opportunities to provide constructive feedback:

- What part of the model makes the device lift/turn/open?
- What specific parts of the model demonstrate hydraulics and/or pneumatics?
- How could you modify the design to lift/turn/open more efficiently/faster?
- How could you modify the design to lift/turn/open larger and/or heavier objects?

Essential Graduation Competencies

Creativity and Innovation
This provides learners an opportunity to reflect on creative and innovative works and processes.

Evidence of Learning (Observations)

Watch for moments when learners are **identifying new and/or potential problems** and notice methods they use to **justify their decisions.**

Learners can be invited to share some of their obstacles and solutions as a sort of peer-to-peer feedback and teaching. Facilitating these mini lessons throughout the planning and implementation process will provide learners important opportunities to formulate decisions about their project based on evidence beyond the scope of their own group. For learners experiencing success, it creates an opportunity to develop an awareness of the effectiveness and efficiency of their own strategies.

Essential Graduation Competencies

Critical Thinking
This provides learners an opportunity to formulate decisions based on evidence; analyse and evaluate evidence, arguments, and ideas

Evidence of Learning (Conversations)

Learners can share their obstacles and solutions. This discussion will provide opportunities for others to learn from their peers and reflect on how they might use similar strategies to support their own learning.

Moving Forward

- How could you modify your design to improve it, or to solve a different problem?

Appendix

What is scientific reasoning?

The decisions scientists make have far reaching implications on science, technology, society, and the environment. Much of science involves making decisions based on logic and reasoning. The nature of science requires that learners analyse observations and data to draw conclusions that are well articulated and supported with a logical defense. Learners need to be provided with opportunities to practice scientific reasoning in the development of critical thinking and communicative competencies.

At the P-3 level, learners will engage in scientific reasoning by

- Beginning to recognize multiple viewpoints
- Making decisions and effectively articulating reasons
- Beginning to recognize there are multiple options for solutions
- Evaluating implications of decisions
- Demonstrating respect for the decisions of others

At the 4-6 level, learners will engage in scientific reasoning by

- Recognizing the difference between opinions and evidence
- Beginning to identify questions that have conflicting solutions
- Recognizing multiple viewpoints
- Effectively articulating supporting arguments for a decision
- Using analysis of facts/data to make a decision
- Recognizing there are multiple options for solutions
- Evaluating implications of decisions
- Demonstrating respect for the decisions of others

At the 7-9 level, learners will engage in scientific reasoning by

- Differentiating decisions based on opinions from those supported by evidence or logic
- Identifying questions that have conflicting solutions
- Investigating multiple viewpoints
- Effectively articulating a logical explanation for a decision using evidence
- Using systematic thinking (thorough, reasoned analysis of facts/data) to make a decision
- Identifying multiple options for solutions
- Evaluating a decision
- Demonstrating respect for the decisions of others

At the 10-12 level, learners will engage in scientific reasoning by

- Differentiating decisions based on opinions from those supported by evidence or logic
- Identifying questions that have conflicting solutions
- Communicating/Explaining multiple viewpoints
- Effectively articulating a logical explanation for a decision using evidence from multiple sources
- Using systematic thinking (thorough, reasoned analysis of facts/data) to make a decision
- Evaluating multiple options for solution
- Evaluating a decision
- Demonstrating respect for the decisions of others

Science Scope and Sequence - Overview

Gr.	Life Sciences	Physical Sciences	Earth and Space Sciences	Nature of Science – Scientific Processes
P	Living Things	Materials Movement	Sand and Water	Gathering observations using the senses Asking testable questions Investigating cause and effect Fair test Testing variables Controlling variables Using evidence to make conclusions
1	Needs of living things	Materials, objects and devices	Daily and Seasonal Changes	
2	Animal Growth and Changes	Liquids, solids and mixtures Motion	Air and water in the environment	
3	Plants	Invisible forces Structures	Soil	
4	Habitats	Light Sound	Rocks and minerals	Gathering observations using tools Presenting collected data multiple ways Identifying patterns in results and observations Investigating properties and change Designing simple experiments to control variables Using results of experimentation to make claims
5	Healthy body and body systems	Forces and simple machines Chemical and physical properties and changes of matter	Weather	
6	Diversity of life	Electricity Flight	Space components	
7	Environmental Action: Ecosystem components	Engineering Structures Environmental Action: Solutions Chemistry	Geological Evolution	Systematic approach to scientific inquiry Designing more complex experiments to control variables Data collection, processing and analysis Communication of scientific arguments based on evidence Considering multiple perspectives regarding decision-making and the applications of science
8	Cells and Systems	Climate Change: Heat Hydraulics and Pneumatics: Fluids	Climate Change: Ocean Systems	
9	Reproduction	Atoms and Periodic Table Electricity	Space components and discovery	
10	Ecosystems and Sustainability	Motion Chemical Reactions	Weather	Evaluating scientific designs

11	Body Systems Cell components Cell respiration and Photosynthesis Taxonomy and diversity of life Interactions among living things Biomes Population dynamics	Stoichiometry From Structures to Properties - Bonding Organic Chemistry Kinematics Dynamics Momentum and Energy Waves	Ocean structure and motion Marine Biome Coastal Zones	Examining error and conducting statistical analysis of data Application of the Nature of Science cross-cutting concepts Critically thinking about the outcomes and applications of science with consideration of ethics
12	Nervous and endocrine systems Reproduction DNA Genetics Evolution, Change and Diversity	Thermochemistry from Solutions to Kinetics to Equilibrium - rates of reaction and dynamic equilibrium Acids and Bases Electrochemistry force, Motion, Work and Energy Fields - Magnetic, Electric, Gravitational Waves and Modern Physics including quantum physics	Geology and Earth Systems Crystallography, Mineralogy and Petrology Plate Tectonics Forces and Structures of Earth's Interior Surface Processes: Weathering, Erosion and Deposition Fossil record and Geological Time Environmental Geology	