Science: Grade 10 (20F) Pilot

Course Code	0120
Course Credit	1.0

ENGLISH Program

Discipline Overview

Science is the systematic exploration of the natural world through observation, experimentation, and evidence-based reasoning to build an understanding of it. It emerges from human curiosity and employs creativity, imagination, and intuition to uncover new knowledge.

Science contains a body of established knowledge and provides a philosophical framework for generating new insight into the natural world. Science is shaped by historical, political, economic, environmental, and societal factors, which are integral to understanding its significance as a valuable human endeavor.

In Manitoba, the K–10 Science education rests on the following five dimensions:

- **Indigenous People within the Natural World** – First Nations, Métis, and Inuit have always engaged in scientific ways of knowing, doing and being; all learners of science benefit from developing an understanding of how different Indigenous communities interpret the natural world, apply scientific principles, and create technologies in interrelated and sustainable ways.
- **Science Identity** – Throughout history, peoples from diverse backgrounds have played roles in the development of science and all people, societies, and environments are affected by science and technology; all learners must be empowered to see themselves as participants in the collective scientific endeavour.
- **Scientific Knowledge** – Information, concepts, principles, theories, and facts that have been acquired, tested, and validated through the systematic process of scientific inquiry; all learners must acquire a fundamental core knowledge base to become scientifically literate citizens.
- **Practical Science** – STSE (Science, Technology, Society, and Environment) contexts, measurement, actions and practices, scientific instruments and awareness of science application in careers, hobbies and activities; all learners must be equipped with scientific skills and attitudes to take action for the betterment of society and a sustainable future.
- **Nature of Science** – The purpose, methods, applications, and implications of scientific inquiry; all learners must develop the scientific confidence to navigate the complexities of an information rich environment, including differentiating between legitimate scientific information, pseudoscience, misinformation, and disinformation.

These intertwined dimensions, within which rest a structure of curricular outcomes, put learners on a continuous pathway of increasing scientific literacy. Learners develop their global competencies, which in turn allow them to engage authentically with the curriculum and build enduring understandings of science.

Manitoba

Science is foundational for understanding natural phenomena, solving problems, and in the development of new technology. Through the study of science, learners become scientifically literate; they expand their knowledge, develop critical thinking and data analysis skills, and learn to evaluate procedures effectively. Scientific literacy equips learners to critically engage with information, make informed decisions, and address complex issues on both personal and societal levels. Science education not only fosters responsible citizenship but also nurtures curiosity and encourages interdisciplinary thinking through connections with mathematics, engineering, arts, languages, physical health, and the social sciences.

Course Overview

The Manitoba K–10 science curriculum is constructed with five categories of learning outcomes: Indigenous Peoples within the Natural world, Science Identity, Scientific Knowledge, Practical Science and Nature of Science. Scientific Knowledge and Nature of Science outcomes are organized around building an understanding of fourteen Big Ideas[1] in and about science. Ten Big Ideas in science are addressed via Scientific Knowledge outcomes which are unique to every grade level, while four Big Ideas about science are investigated through the Nature of Science category in four progressive grade bands. The contribution of different First Nations, Inuit and Métis groups are studied in the Indigenous Peoples within the Natural world category, while connecting all students to science inclusively is addressed in the Science Identity category. The Practical Science outcomes emphasize that science is active and participatory.

In **Grade 10**, learners culminate their K–10 science learning and are prepared to continue onto optional sciences at Grades 11 and 12. The knowledge areas of **matter, force, Earth science, space science, life systems,** and **evolution** are explored. Students complete their basic active and practical approach to learning and doing science. This includes conducting scientific investigations, furthering tool and measurement skills, exploring science in everyday life, and looking into how science interacts with society and the environment. Learners strengthen their agency and sense of belonging in science, as well as their science literacy. In Grade 10, they have many opportunities to explore Indigenous ways of knowing, being and doing, including through interacting with local community and land-based learning. The Grades 10–12 band of the NOS outcomes is initiated with a more sophisticated inquiry into the **purpose, method, application,** and **implications** of science. Suggested guiding inquiry questions for the year are:

- How do various types of matter interact?
- What do we know about the Earth and its place in the Universe?
- How are human activities affecting the environment?

Please see documents in the key resources section for more information on how to use this curriculum.

1 See BISE document.

Global Competencies in Science

Critical Thinking

Critical thinking in science involves using empirical evidence to test ideas, solve problems, and deepen scientific knowledge; critical thinking is an essential aspect of scientific inquiry. Critical thinkers use various processes and wide sources of evidence to distinguish good information from bad. Thinking critically leads to the discovery of relationships within and between various phenomena. Through scientific critical thinking, theories are formed and tested; they are reinforced, challenged, shifted, or abandoned.

Learners

- use strategic, efficient, and effective research skills to find and use reliable sources.
- display scientifically valid skepticism when evaluating sources of information for bias, reliability, and relevance.
- observe, test, and experiment to explore and connect ideas, patterns and relationships, using scientific criteria and evidence.
- reflect on a position from multiple scientific perspectives and defend, adjust, or change position based on scientific evidence and feedback from peers.
- are willing to ask scientifically relevant questions to further their understanding.
- make judgements based on the best available scientific evidence, observations, and experiences.
- weigh criteria to make ethical scientific decisions when their actions may affect themselves, others, living things, or the environment.

Creativity

Creativity in science involves the exploration of scientific ideas, processes, problems, and issues. Science is a creative process with the goals of generating new ideas, products, processes and producing evidence for well-informed decision making. Scientific thinkers use the best available evidence to build theories to explain phenomena in the physical world, and they create experiments to test those theories. This process may lead to shifts in human understanding, and to new technologies.

Learners

- demonstrate initiative, open-mindedness, inventiveness, flexibility, and a willingness to take prudent risks.
- demonstrate curiosity about the natural world, ask scientifically relevant questions, and are comfortable playing with ideas.

- employ scientific strategies to solve problems by applying their knowledge and ideas in innovative ways.
- deepen their understanding of scientific concepts by building on the ideas of their peers and endeavoring to see the world through a variety of lenses.
- create plans and adjust them as needed to experimentally investigate a problem or in product design.
- test and adapt plans used during inquiry, design, or decision-making processes and persevere through obstacles to improve.

Citizenship

Citizenship in science involves a recognition and understanding of the consequences of scientific decisions and practices on oneself, others, and the natural world. Scientific approaches to knowledge acquisition recognize the fallibility of human faculties, including the limitations of perception and natural human biases. Citizenship in science involves participating in a process of peer review and acknowledging that people from all cultures and backgrounds have contributed understandings of the physical world. The world's accumulated scientific knowledge serves to help sustain and better humanity and the environment; it should be ethically gathered, willingly shared, and passed from generation to generation.

Learners

- understand that science often deals with complex issues, on which varying perspectives may exist.
- explore the interconnectedness of self, others, and the natural world.
- evaluate factors and propose scientifically valid solutions considerate of the well-being of self, others, and the natural world.
- welcome diverse scientific viewpoints because they understand that contributions to science come from those with varied backgrounds, experiences, and world views.
- are respectful of their peers' perspectives, even those that do not fit their own.
- communicate with their science community in a responsible, respectful, and inclusive ways.
- contribute to the betterment of community both near and far, in doing scientific investigations.
- seek equitable solutions to scientific issues which support diversity, inclusivity, and human rights.
- make ethical decisions based on evidence, which have a positive and sustainable impact on self, others, and the natural world.

Connection to Self

Connection to self in science involves learners developing confidence in their abilities in science, and a positive relationship to science. Scientific thinking is a skill which can be learned, and which has valuable applications to daily life. The practice of science involves prudent risk taking, exercising curiosity, analytical evaluation of beliefs, and a willingness to grow and change based on verifiable information. Engaging in scientific practice teaches individual resiliency, perseverance, and promotes an understanding of one's place in the natural world.

Learners

- acknowledge their personal interests, strengths, gifts, and challenges in making connections between science and their lives.
- come to know factors that shape their scientific identity and to understand that everyone is a scientist.
- understand and use strategies to support self-regulation during scientific investigations and when receiving peer feedback.
- reflect on their scientific decisions, effort, and experience and accept that acknowledging feedback from others is part of the scientific process.
- set goals to strengthen their scientific learning progress and well-being, as part of the scientific process.
- recognize that a scientific understanding of the natural world can instill hope and optimism about the future.
- are resilient and persevere through obstacles recognizing that they will learn from mistakes and build upon their successes.
- demonstrate the ability to critically evaluate their own ideas and beliefs and are open minded to adapt and change to new evidence.
- value their own voice, build their confidence and embrace their role as life-long science learners.

Collaboration

Collaboration in science involves learning with and from others to elaborate scientific ideas and processes. The process of peer review, and the seeking of expert consensus, are valued practices in the scientific endeavour. The advancement of science often occurs through collaboration amongst scientists and teams of scientists.

Learners

- seek to understand diverse perspectives, voices, and ideas, seeing these as integral components of the scientific process.
- understand that in science, new ideas often build upon the contributions and ideas of others.

- value the scientific contributions of others.
- participate in the process of asking scientific questions of themselves and others, and actively listening to responses.
- contribute by working through differences and show a willingness to compromise or change perspective in response to scientific evidence, as participating members of scientific teams.
- collaboratively gather and interpret empirical data, striving for a shared understanding of its scientific meaning.
- commit to their role as part of a team with a collective purpose towards a common goal in inquiry, design, and decision-making processes.

Communication

Communication in science involves interaction with others to share scientific ideas and information in diverse contexts. The clear communication of scientific information is a vital part of the scientific endeavor. What is communicated as scientific knowledge must be credible, open to interrogation by experts, testable and verifiable. Scientific communication often conveys information in mathematical, graphical, and technical formats and must acknowledge the limitations and uncertainties inherent in quantitative empirical investigations. The language and symbols within narrow fields often becomes extremely specialized. Communication between fields, and from scientific communities to the public, often requires interpretation by teachers, journalists, and other science communicators.

Learners

- express ideas and organize information clearly and succinctly using appropriate scientific terminology and representations, including uncertainty and error.
- use multiples modes and forms of communication to share scientific ideas, which account for purpose, context, and audience.
- understand how their words and actions shape their identity both in person and online.
- use their scientific background and context cues to enhance understanding of scientific communications.
- seek to understand the scientific perspective of their peers through active listening and questioning.
- deepen their understanding of scientific ideas by making connections and building relationship through conversation, discussion, and interaction in a variety of contexts and through varied media.
- advocate for themselves and others in constructive and responsible ways to strengthen their scientific community.

Enduring Understandings in K to 12 Science

Science is about explaining phenomena.

Science explains the cause or causes of phenomena observed in the natural world using various scientific practices to do so.

Science is a collective endeavour.

Science is a collective human endeavour that discovers laws, builds models, and formulates theories that best fit the empirical evidence available at a particular time.

Science is interconnected with technology.

Science is a symbiotic relationship between scientific understandings and technological developments for the solution of problems.

Science has complex implications.

Science and its applications have ethical, social, personal, economic, political, cultural and environmental implications, such as considerations of sustainability, ethics, or social justice.

Science empowers human agency.

Science fosters curiosity and develops a science identity which supports a lifelong interest and informs decision making and agency in everyday life.

Learning Outcomes

Indigenous Peoples within the Natural World Outcome

SCI.10.INW.1 Demonstrate an understanding of different First Nations, Métis and Inuit ways of knowing, being and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected and sustainable ways, land-based learning, intersections with Western science, etc.).

Science Identity Outcome

SCI.10.SI.1 Develop a sense of agency, identity and belonging in science by

- cultivating natural curiosity about the world.
- acquiring scientific skills and fostering scientific attitudes.
- building a personal connection to nature.
- establishing links between science concepts and personal experience.
- recognizing that everyone can contribute to science.

Practical Science Outcomes

Science, Technology, Society, and Environment (STSE) Contexts

SCI.10.PS.1 Demonstrate an awareness of the dynamic interplay between science, technology, society, and the environment (STSE), empowering learners to critically evaluate the impacts of scientific and technological advancements on individuals, communities, and ecosystems, and to make informed decision for a sustainable future.

Examples:

types of reactions seen in everyday life (combustion, oxidation, acid base chemistry, etc.); chemistry in health care; the importance of systematic organization in chemistry; transportation; physics safety and technology; atmospheric pressure and weather; pressure based technologies (pneumatics, hydraulics etc.); forces and traditional indigenous technologies; the development of and evidence for the Big Bang theory; cosmologies of various cultures, including intersection of science, religion, and philosophy; celestial bodies and various significance and teachings; causes and consequences of climate change; climate change mitigation strategies and sustainability; geological time scales and evidence of past and current extinction events; conservation and protection of land, water and ecosystems; sustainable resource management; wildlife-human interactions and coexistence; the relationship between human culture and technological development; etc.

Scientific Measurement

SCI.10.PS.2 Demonstrate an understanding of the units, measuring tools, and nature of measurement in science*.

Include:

Tools: thermometer, ruler, volumetric vessels, stopwatch, spring scale, caliper, digital scale, **barometer, telescope**

Attributes: temperature, length, weight, volume, time, speed, force, direction, energy, density, pressure

Units: length/distance (**parsec, light year, astronomical unit**, km, m, cm, mm, mm fractions), weight (kg, g, **cg, mg**), volume (L, mL), time (h, min, s), temperature (^{o}C), speed (km/h, m/s), force (N), energy (J), density (kg/m^3, g/cm^3), pressure (kPa, Pa)

Skills: Measure and estimate using standard SI tools and units, select measurement tools, display quantitative data (charts, line graphs, tables etc.), recognize importance of standard units, convert between SI length, time, and volume units, understand meaning of SI prefixes and their symbols (micro, milli, centi, deci, deka, hecto, kilo, mega), describe the definition and relationship between SI units m and kg (historical and modern definitions), differentiate between base SI units (m, kg, s, A) and derived units (N, C, W, etc.), understand measurement precision, accuracy, uncertainty **(+/- notation)**, use unit/dimensional analysis techniques to check computation, **use scientific notation and metric prefixes to represent large and small SI measurements**

* **Bold** indicates items introduced for the first time at this grade level

Action and Practice

SCI.10.PS.3 Demonstrate practical scientific skills through safely and actively participating in a variety of scientific practices such as inquiry-based learning experiences, experimentation, scientific observation, data analysis, measurement, debate, communicating scientific information, design and build, etc.

Examples:

- Invite an Elder or a Knowledge Keeper to share Indigenous Teachings.
- Investigate the potential impact of introducing invasive species to an ecosystem or removing a species from an ecosystem.
- Design and perform an experiment to determine how various factors affect chemical reaction rates, including identifying and controlling major variables.
- Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize the Earth’s 4.6-billion-year-old history.
- Demonstrate knowledge and use of relevant safety precautions, WHMIS regulations, and emergency equipment.

Scientific Instruments

SCI.10.PS.4 Demonstrate an understanding of the purpose and functioning of various scientific instruments and materials (considering availability and appropriateness), as well as competence in using them safely.

Examples:

glassware, hot plate, chemical substances, Bunsen burner, telescope, craft and recycled materials, classroom materials, nature materials, logbook, diagrams, charts, graphs, spreadsheets, safety procedures, etc.

Careers, Hobbies, and Activities

SCI.10.PS.5 Demonstrate an understanding of the connections between the scientific ideas studied and a range of careers, hobbies, and activities.

Examples:

chemist, firefighter, EMT, engineer, materials scientist, pharmacist, driver, astronomer, space scientist, rocket engineer, communications expert, roboticist, miner, ecologist, environmental scientist, waste management expert, gardening, ethnobotany, indigenous storytelling related to life interconnectedness, model building, skateboarding, biking, star gazing, nature walks, camping, nature photography, bowling, basketball, rock climbing, rock, and mineral collecting, etc.

Nature of Science Outcomes (10–12 Band)

Purpose: Science is about finding the cause or causes of phenomena in the natural world.

SCI.10.NOS.1 Demonstrate an understanding that scientific evidence is gathered through experimentation where possible, or systematic observations where it is not.

SCI.10.NOS.2 Demonstrate an understanding that patterns in data may reveal correlations between factors in phenomena.

SCI.10.NOS.3 Demonstrate an understanding that correlations in data suggest relations between factors but are not conclusive evidence that one factor is the cause of change in another because undiscovered factors could be causing both.

SCI.10.NOS.4 Demonstrate an understanding that in science, there is a difference between theories, models, hypotheses, and laws, including the fact that one does not become another, and all are important parts of the development of scientific understandings.

Method: Scientific explanations, theories and models are those that best fit the evidence available at a particular time.

SCI.10.NOS.5 Demonstrate an understanding of how models are used in science.

Example: prediction, simplification, representation, testing, etc.

SCI.10.NOS.6 Demonstrate an understanding that theories and models are created by humans using intuition, reason, imagination, and consideration of evidence.

SCI.10.NOS.7 Demonstrate an understanding of the nature of scientific theories and models and how they may change as new evidence becomes available.

Example: modify, replace, discard, paradigm shift

SCI.10.NOS.8 Demonstrate an understanding that theories are tested by experiment and observation and may be strengthened, modified, or discarded, but they cannot be proven correct.

Include: problem of induction, black swan theory, falsifiability

Application: The knowledge produced by science is used in engineering and technologies to create products to serve human ends.

SCI.10.NOS.9 Demonstrate an understanding of the way in which scientific knowledge and technological advancement enable and reinforce each other in a reciprocal fashion.

SCI.10.NOS.10 Demonstrate an understanding that technologies may provide many advantages, but often have aspects that are detrimental.

Example: climate change, environmental damage, disposal, mass consumption

SCI.10.NOS.11 Demonstrate an understanding that some technologies consume rare and finite resources, requiring collaboration between scientists and engineers to find sustainable solutions.

Example: sustainable development, environmental damage, non-renewable resource, rare metals, recycling, reuse

Implication: Applications of science often have ethical, social, economic, and political implications.

SCI.10.NOS.12 Demonstrate an understanding that established science is not a matter of opinion; however, how scientific knowledge is applied requires ethical and moral judgments that are outside the realm of science.

SCI.10.NOS.13 Demonstrate an understanding that all technologies consume or degrade resources of some kind, requiring considerations beyond what the technology or science itself can provide.

Example: economical, social, health, ethical, political, environmental, sustainability, etc.

Knowledge Outcomes

Matter: All matter in the Universe is made of very small particles

SCI.10.SK.1 Demonstrate an understanding that chemical reactions involve the joining or rearrangement of atoms in the reacting substances, resulting in the formation of new substances.

Include: conservation of mass, reaction equations, balancing equations, chemical bonds

SCI.10.SK.2 Demonstrate an understanding that the observable properties and behaviors of elements and compounds can be explained in terms of the arrangement of electrons, and the bonds between atoms or molecules.

Example: metals, non-metals, Bohr models, ionic compounds, molecules, solids, liquids, gasses, boiling point, melting point, reactivity, etc.

SCI.10.SK.3 Demonstrate an understanding of the nature of the formation and properties of binary ionic compounds.

Include: metal, non-metal, valence electron, ionic bond, crystal, melting point, boiling point, electrolyte

SCI.10.SK.4 Demonstrate an understanding of the nature of the formation and properties of simple molecular compounds.

Include: valence shell, covalent bond, single bond, double bond, triple bond, melting point, boiling point, states of matter

SCI.10.SK.5 Demonstrate an understanding that scientists name molecular and ionic compounds systematically, according to IUPAC rules.

Include: prefix, suffix, Stock System

Note: Learners expecting to enter Grade 11 chemistry should learn basic naming. Other learners need only demonstrate an awareness of the importance of systematically naming compounds.

Force: Changing the movement of an object requires a net force to be acting on it.

SCI.10.SK.6 Demonstrate an understanding of the concepts of position, time, displacement, velocity, and constant acceleration.

Include: vector, scalar, distance, speed, and correct application of related SI units

SCI.10.SK.7 Demonstrate an understanding of the relationship between forces, masses and changing velocities as described and understood through Newton's three laws of motion.

Include: mass, kilogram, inertia, definition of Newton (N), vector, acceleration, friction

SCI.10.SK.8 Demonstrate an understanding that pressure is a measure of force acting on a unit of area.

Include: pascal, kilopascal, m^2, N

SCI.10.SK.9 Demonstrate an understanding that liquids, gases, and solids exert pressures, and that the amount of pressure depends on various factors.

Include: density, gravity, volume, temperature, depth, height

Earth Science: The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.

SCI.10.SK.10 Demonstrate an understanding of the nature and importance of the ozone layer.

Include: formation from oxygen, molecular composition, blocking UV rays, CFC damage

SCI.10.SK.11 Demonstrate an understanding of global efforts made to reverse ozone damage.

Include: ozone hole, Montreal protocol

SCI.10.SK.12 Demonstrate an understanding of factors which influence the Earth's climate system.

Example: latitude, Sun energy, landscape, prevailing wind, Coriolis effect, ocean currents, etc.

SCI.10.SK.13 Demonstrate an understanding of the nature, importance, and extraction of natural resources contained within the Earth.

Include: fossil fuels, ores, minerals, metals

SCI.10.SK.14 Demonstrate an understanding of the mechanism and consequences (e.g. severe weather events, ocean acidification, desertification, loss of polar ice, wildfires, flooding, etc.) of human induced climate change.

Include: greenhouse gas emissions

Space Science: Our solar system is a very small part of one of billions of galaxies in the Universe.

SCI.10.SK.15 Demonstrate an understanding of the vast size of the universe, its varied contents, and evidence for its formation in the 'big bang', and subsequent evolution.

Include: light year, parsec, astronomical unit, doppler shift, galaxies

SCI.10.SK.16 Demonstrate an understanding of the formation and evolution of our solar system, and the solar system's place and time in the larger universe.

Include: gravity, accretion, star, age of universe, age of solar system, age of Earth

SCI.10.SK.17 Demonstrate an understanding of the varying nature of stars, including the formation, types, mechanism of energy production, and progression through a life cycle.

Include: types of stars, evolution of stars, star birth, main sequence, star death, nuclear fusion

SCI.10.SK.18 Demonstrate an understanding that celestial objects, and objects on the Earth, all obey the same relatively simple laws of gravity and motion, which lead to mainly regular and predictable motions in the night sky, and occasionally to less predictable phenomena.

Example: meteor activity

SCI.10.SK.19 Demonstrate an understanding that evidence of life has not been found anywhere beyond the Earth.

Life Systems: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.

SCI.10.SK.20 Demonstrate an understanding of the nature and functioning of resilient ecosystems.

Include: food web, ecological pyramids, biogeochemical cycles, biodiversity, carrying capacity

SCI.10.SK.21 Demonstrate an understanding that many human activities have a detrimental effect on natural, healthy ecosystems.

Example: monoculture, farming, forestry, mining, lake eutrophication, invasive species, habitat destruction, bioaccumulation, climate change, urbanization, building dams, and dissemination of invasive species, etc.

SCI.10.SK.22 Demonstrate an understanding that there are sustainable alternatives to most detrimental human activities.

Example: sustainable agriculture practices, renewable energy resources, etc.

Evolution: The diversity of organisms, living and extinct, is the result of evolution.

SCI.10.SK.23 Demonstrate an understanding that evolution of living things is an aspect of a larger process called 'cosmic evolution' which has led to conditions favorable to life on Earth.

SCI.10.SK.24 Demonstrate an understanding that human activity changes environments more quickly than organisms can naturally evolve.

Include: climate change, pollution, monoculture, biodiversity, Anthropocene extinction, pesticides, fertilization, habitat destruction

SCI.10.SK.25 Demonstrate an understanding that humans can intentionally or unintentionally influence the evolution of species.

Example: selective breeding, domestication, genetic modification, antibiotic resistance, peppered moth, etc.

Curriculum Implementation Resources

Curriculum implementation resources will include supplementary documents to support implementation. Feedback during the pilot phase will guide the development of the Curriculum Implementation Resources section.