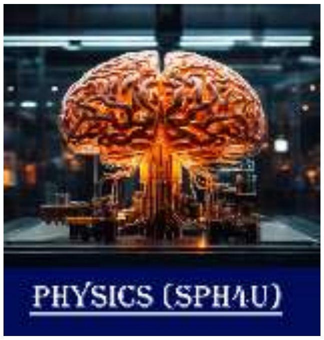

INUKSHUK ACADEMY

Course code: **Physics (SPH4U)**
Total Hours: **110 hours** and Credit: **1.0**
Prerequisite: **Physics, Grade 11, University Preparation**
Curriculum basis**: Ontario Curriculum, Grades 11–12: Science (Revised 2008)**
Last Update: **Inukshuk Academy 2026**

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Course Description

This course enables students to deepen their understanding of physics concepts and theories. Students will continue their exploration of energy transformations and the forces that affect motion, and will investigate electrical, gravitational, and magnetic fields and electromagnetic radiation. Students will also explore the wave nature of light, quantum mechanics, and special relativity. They will further develop their scientific investigation skills, learning, for example, how to analyse, qualitatively and quantitatively, data related to a variety of physics concepts and principles. Students will also consider the impact of technological applications of physics on society and the environment.

1. Course Rationale

Physics provides the theoretical and mathematical framework for understanding the natural world. SPH4U strengthens students' ability to interpret physical systems, evaluate scientific models, and construct logical arguments based on evidence. Through inquiry, experimentation, and modelling, students:

- Develop a deeper understanding of classical physics and how it describes forces, energy, and interactions;
- Explore modern physics concepts that broaden the boundaries of scientific knowledge;
- Refine advanced mathematical skills essential for STEM disciplines;
- Learn to critically analyze data, verify results, and assess experimental limitations;
- Recognize the impacts of physics-based technologies on society and the environment.

The course fosters scientific literacy, critical thinking, and technological fluency, skills essential for success in university-level programs and careers in engineering, physics, and the applied sciences.

2. Overall Curriculum Expectations

The Ontario Curriculum organizes SPH4U into five major strands. The following expectations are paraphrased for clarity and alignment with Inukshuk Academy's course design.

a. Scientific Investigation Skills

Students will:

- Demonstrate advanced inquiry skills in planning, conducting, and evaluating experiments;
- Analyze data, assess uncertainty, and draw valid conclusions;
- Communicate scientific ideas using appropriate terminology and representations.

b. Dynamics: Motion in Two Dimensions

Students will:

- Analyze forces acting on objects in two-dimensional systems;
- Apply Newtonian mechanics to uniformly circular motion and non-linear motion;
- Solve vector-based motion problems and evaluate technological applications.

c. Energy and Momentum

Students will:

- Investigate and apply the laws of conservation of energy and momentum in 1D and 2D;
- Analyze collisions and energy transformations;
- Evaluate technologies involving energy transfer and mechanical systems.

d. Gravitational, Electric, and Magnetic Fields

Students will:

- Compare gravitational, electric, and magnetic fields and their interactions with matter;
- Solve quantitative field problems using vector reasoning;
- Assess technologies that use field concepts (motors, satellites, accelerators).

e. The Wave Nature of Light

Students will:

- Analyze wave behaviour including interference, diffraction, and polarization;
- Model the propagation, reflection, and refraction of light;
- Evaluate optical and photonic technologies.

f. Modern Physics: Quantum Mechanics and Relativity

Students will:

- Investigate quantum phenomena such as wave–particle duality and the photoelectric effect;
- Explore the foundations and implications of special relativity;
- Explain how scientific models evolve and contribute to technological innovation.

3. Learning Goals for Students

By the end of SPH4U, students will be able to:

- Analyze complex physical systems using vector-based mathematics and scientific models;
- Conduct investigations using proper experimental design and error analysis;
- Apply conservation laws, field theory, wave models, and modern physics concepts to solve problems;
- Interpret physical data using graphs, equations, and scientific notation;
- Evaluate the impact of physics-related technologies on society and the environment;
- Communicate scientific reasoning clearly, using appropriate diagrams, terminology, and units.

Course Structure and Instructional Units

Unit	Description	Hours
Unit 0: Scientific Skills and Measurement	Lab skills, uncertainty, significant digits, error analysis, unit conversion	5 hours
Unit 1: Motion in Two Dimensions	Dynamics, circular motion, non-linear forces, vector analysis	30 hours
Unit 2: Energy and Momentum	Work, energy, collisions, conservation laws	20 hours
Unit 3: Gravitational, Electric, and Magnetic Fields	Field theory, vector fields, force laws, field interactions	22 hours
Unit 4: Wave Nature of Light	Interference, diffraction, refraction, optical systems	13 hours
Unit 5: Modern Physics	Quantum phenomena, relativity, technological impacts	13 hours
Culminating Task	Investigation or applied project	5 hours
Final Exam	Proctored examination	2 hours

4. Course Structure, Unit Overview and Instructional Plan

1. Unit 0: Scientific Skills and Measurement

Approx. Hours: 5

a. Unit Overview

This introductory unit strengthens the foundational scientific skills students need for advanced physics investigations. Students review and refine their ability to work with significant digits, measurement precision, uncertainty, and unit conversions. They examine the role of error analysis in interpreting results and evaluating experimental reliability, drawing clear distinctions between systematic and random errors.

b. Key Learning Goals

Students will:

- Apply rules for significant digits consistently in calculations;
- Use dimensional (unit) analysis to verify formulas and check solutions;
- Identify and quantify sources of measurement error;
- Represent uncertainty appropriately in laboratory and computational contexts.

c. Sample Learning and Assessment Activities

- Measurement labs (timing cycles, measuring acceleration, small-angle approximations);
- Error propagation exercises;
- Problem sets involving unit conversions across SI and derived units.
- Diagnostic math/physics review, scientific notation tasks, error analysis report.

2. Unit 1: Motion in Two Dimensions

Approx. Hours: 30

a. Unit Overview

In this unit, students extend their understanding of kinematics and dynamics into two-dimensional systems. They analyze forces involved in uniform circular motion, non-uniform motion, projectile motion, and the combined effects of perpendicular force components. Vector operations, including addition, subtraction, components, and equilibrium, form the mathematical basis for problem solving.

Students examine how Newton's laws apply to objects undergoing circular motion or motion constrained in a plane. They explore centripetal force, frictional interactions, torque, and applied force systems. Technological applications, such as transportation systems and mechanical devices, provide context for understanding the societal and environmental implications of dynamic systems.

b. Key Learning Goals

Students will:

- Analyze motion in two dimensions using vector methods;
- Apply Newton's laws to circular and planar motion;
- Solve problems involving centripetal acceleration, friction, and non-linear force systems;
- Evaluate technologies that use principles of dynamics (e.g., roller coasters, satellites);
- Conduct laboratory investigations to collect and interpret motion data.

c. Sample Learning and Assessment Activities

- Motion tracking with digital sensors or video analysis tools;
- Vector resolution and equilibrium tasks;
- Circular motion lab using rotational apparatus;
- Case studies examining transportation technologies.
- Quantitative problem sets, lab reports, conceptual quizzes, unit test.

3. Unit 2: Energy and Momentum

Approx. Hours: 20

a. Unit Overview

Students examine the conservation of energy and momentum through mathematical modelling and laboratory inquiry. The unit covers work, kinetic and potential energy, elastic and inelastic collisions, impulse, and the relationships between force and momentum change. Learners investigate energy transfer within systems and compare energy efficiency and loss in real scenarios.

The unit places strong emphasis on analyzing collisions in one and two dimensions. Students use vector components, graphs, and algebraic relationships to justify the conservation of momentum and evaluate whether real-world collisions deviate from ideal predictions due to friction, deformation, or heat transfer.

b. Key Learning Goals

Students will:

- Apply the work–energy theorem to mechanical systems;
- Differentiate between elastic, partially elastic, and inelastic collisions;
- Use conservation laws to solve 1D and 2D collision problems;
- Evaluate technologies based on momentum and energy transfer (e.g., airbags, sports equipment);
- Conduct experiments using sensors to measure momentum and energy changes.

c. Sample Learning and Assessment Activities

- Momentum cart collisions using Vernier or Pasco systems;
- Energy conservation analysis in spring oscillators;
- Collision simulations comparing theoretical and experimental results.
- Problem sets, collision lab report, modelling tasks, unit test.

4. Unit 3: Gravitational, Electric, and Magnetic Fields

Approx. Hours: 22

a. Unit Overview

This unit introduces students to classical field theory through gravitational, electric, and magnetic fields. Students compare field strengths, directions, and interactions using diagrams, equations, and vector calculations. They learn how fields exert forces on matter at a distance, analyze field lines and equipotential, and apply inverse-square relationships to solve problems.

Students explore applications such as planetary orbits, electric circuits, motors, generators, and electromagnetic technologies. Inquiry activities allow learners to visualize fields through simulations and mapping exercises.

b. Key Learning Goals

Students will:

- Describe and compare gravitational, electric, and magnetic fields;
- Solve quantitative field problems using vector operations;
- Apply Coulomb's law, Newton's law of gravitation, and right-hand rules;
- Map electric and magnetic fields using simulations or sensors;
- Evaluate technologies based on field interactions (e.g., MRI machines, magnetic levitation).

c. Sample Learning and Assessment Activities

- Electric field mapping using conductors and voltmeters;
- Magnetic field investigations using compasses or sensors;
- Gravitation problems involving planetary motion and orbits;
- Simulations demonstrating field interactions.
- Field analysis tasks, lab investigations, conceptual quizzes, unit test.

5. Unit 4: Wave Nature of Light

Approx. Hours: 13

a. Unit Overview

Students investigate the behaviour of mechanical waves and light, focusing on wave–particle interactions and the mathematical relationships governing wave phenomena. Topics include diffraction, interference, superposition, polarization, and refraction.

Laboratory investigations and simulations help students understand how waves propagate and interact. Students examine technologies based on wave principles, including fibre optics, communication systems, lasers, and imaging devices.

b. Key Learning Goals

Students will:

- Describe the wave properties of light and mechanical waves;
- Analyze interference and diffraction patterns mathematically;
- Model refraction using Snell's law and index of refraction;
- Evaluate technologies that rely on optical principles;
- Conduct wave experiments and interpret collected data.

c. Sample Learning and Assessment Activities

- Single-slit and double-slit diffraction investigations;
- Laser refraction lab;
- Wave interference simulations;
- Optical technology case studies.
- Investigation reports, wave analysis problems, optical modelling tasks.

6. Unit 5: Modern Physics - Quantum Mechanics and Relativity

Approx. Hours: 13

a. Unit Overview

This final unit introduces students to foundational ideas in quantum mechanics and special relativity. Students explore evidence for quantized energy, wave–particle duality, the photoelectric effect, and the uncertainty principle. They study relativistic motion, time dilation, length contraction, and the relationship between energy and mass.

Students analyze how new scientific models reshape scientific understanding and lead to technological innovation from semiconductors to nuclear medicine to particle physics.

b. Key Learning Goals

Students will:

- Interpret wave–particle duality using historical and experimental evidence;
- Analyze the photoelectric effect and related quantum models;
- Apply concepts of special relativity to solve mathematical problems;
- Evaluate how quantum and relativistic theories influence modern technologies;
- Explain how scientific models evolve through experimentation and refinement.

c. Sample Learning and Assessment Activities

- Quantum simulation tools (e.g., PhET models of the photoelectric effect);
- Relativity scenario problems;
- Research task on emerging quantum technologies;
- Conceptual discussions comparing classical and modern physics.
- Modern physics assignments, simulations analysis, unit test.

Instructional Approaches

Teaching and learning in SPH4U at Inukshuk Academy incorporate a wide range of strategies to ensure students develop deep conceptual understanding, strong analytical skills, and confidence in applying physics to real-world contexts. Instruction is guided by the principles of inquiry-based learning, scientific investigation, and the scientific and mathematical processes in the Ontario Curriculum.

a. Inquiry-Based and Experiential Learning

Students learn physics most effectively by doing physics. Lessons regularly include hands-on investigations, data collection, simulations, modelling tasks, and structured inquiry activities that reinforce major scientific concepts.

Examples include:

- Designing experiments to measure circular motion;
- Mapping electric or magnetic fields;
- Analyzing collision data to confirm conservation laws;
- Exploring diffraction and interference using laser equipment or virtual labs.

b. Multiple Representations of Concepts

Students encounter all physics ideas through a combination of:

- Mathematical equations and models;
- Graphs and diagrams;
- Written explanations;
- Simulations and visualizations;
- Physical demonstrations.

This approach supports deeper conceptual connections and allows students to choose the representation that best supports their understanding.

c. Use of Technology and Digital Tools

Digital tools are integrated throughout the course to enhance learning and support scientific inquiry. Technology is used to:

- Collect and analyze data (e.g., Vernier/Pasco sensors);
- Model motion and field interactions;
- Visualize wave and quantum phenomena;
- Create graphs and interpret trends;
- Perform vector calculations;
- Simulate relativistic effects.

Examples include PhET simulations, Desmos, GeoGebra, and 3D visualization tools for vectors and fields.

d. Collaborative Problem Solving

Physics is often collaborative. Students work in pairs or small groups to:

- Solve multi-step quantitative problems;
- Conduct joint investigations;
- Discuss and compare solution strategies;
- Critique and refine each other's explanations.

Group learning strengthens communication skills and builds confidence in scientific reasoning.

e. Differentiated Instruction

Instruction is adapted to accommodate different learning needs, readiness levels, and interests. Strategies include:

- Scaffolder problem sets with increasing complexity;
- Enrichment tasks for advanced learners;
- Alternative representations for students who benefit from visual or conceptual approaches;
- Targeted support for students needing additional time or review.

f. Explicit Teaching of Scientific Inquiry Skills

Students receive direct instruction in how to plan and carry out experiments, including:

- Hypothesis formulation;
- Variable identification;
- Data analysis and graphing;
- Error analysis;
- Evaluating sources of uncertainty;
- Drawing justified conclusions.

Assessment and Evaluation

Assessment in SPH4U aligns with the principles of *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools* (2010). Evaluation reflects students' most consistent achievement, with emphasis on recent evidence.

Assessment serves three purposes:

a. Assessment for Learning (Diagnostic)

- Initial math/physics skills review;
- Short diagnostic quizzes to identify early gaps;
- Informal observations.

b. Assessment as Learning (Formative)

- Homework and practice problem sets;
- Lab activities with iterative feedback;
- Concept checks and reflection tasks;
- Draft submissions of investigations.

c. Assessment of Learning (Summative)

- Unit tests on major strands;
- Lab reports and inquiry investigations;
- Research or modelling assignments;
- Culminating performance task;
- Final exam.

d. Achievement Chart Categories

Student achievement is evaluated across the four categories defined in the Ontario Curriculum for Science:

Knowledge & Understanding (30 percent): Mastery of physics concepts and principles, including forces, fields, wave behaviour, energy, momentum, quantum models, and relativity.

Thinking & Inquiry (20 percent): Ability to plan investigations, analyze data, evaluate uncertainty, solve problems, and apply logical reasoning.

Communication (20 percent): Clarity and precision in scientific writing, diagrams, graphs, mathematical notation, and explanation of reasoning.

Application (30 percent): Transfer of knowledge to new contexts, technological systems, real-world problems, and cross-disciplinary applications.

e. Final Evaluation (30 percent)

The final evaluation consists of:

1. Culminating Performance Task (10–15 percent)

A multi-step applied physics investigation or project. Examples include:

- Analyzing the efficiency of an energy transfer system;
- Modelling gravitational or electric field behaviour;
- Designing a wave-based communication system;
- Researching a modern physics technology.

2. Final Examination (15–20 percent)

A proctored exam assessing broad conceptual understanding, mathematical reasoning, inquiry skills, and application across all units.

3. Summary of Achievement Levels and Percentage Grade Ranges

Student achievement in secondary school courses is evaluated according to the Ontario Ministry of Education's four-level scale. Each percentage mark corresponds to a level of achievement, as outlined below.

Percentage Grade Range	Achievement Level	Summary Description
80–100%	**Level 4**	Demonstrates a *very high to outstanding* level of achievement. Performance exceeds the provincial standard.
70–79%	**Level 3**	Demonstrates a *high* level of achievement. Performance meets the provincial standard. *(This is the provincial expectation for student performance.)*
60–69%	**Level 2**	Demonstrates a *moderate* level of achievement. Performance is below but approaching the provincial standard.
50–59%	**Level 1**	Demonstrates a *passable* level of achievement. Performance is significantly below the provincial standard. Further improvement is required for continued success.
Below 50%	**Level 0**	**Insufficient achievement.** Curriculum expectations have not been met. *A credit will not be granted.*

Academic Honesty and Integrity Policy

Inukshuk Academy is committed to fostering a learning environment based on honesty, responsibility, respect, and academic integrity. Students are expected to submit original work and properly acknowledge all sources of information, ideas, images, data, and wording used in assignments and investigations. Academic honesty is essential to maintaining fairness and trust in the evaluation process.

All submitted work must represent the student's own understanding and effort. Sources must be documented appropriately using MLA or APA citation style, as directed by the teacher. The use of generative artificial intelligence tools (e.g., ChatGPT) or other forms of external assistance must be disclosed and approved by the teacher. Undisclosed or inappropriate use of such tools may be treated as academic dishonesty.

Students may be asked to provide process work, rough drafts, notes, calculations, or planning documents to verify authorship and learning progress. If academic dishonesty occurs, the student and Principal may be notified, and consequences will be applied in accordance with school policy. Repeated incidents may result in escalating consequences.

1. Improper Citation

Improper citation occurs when a student fails to use appropriate citation formatting when referencing sources.

Grade Level	First Instance	Subsequent Instances
Grades 9–10	Warning and opportunity to resubmit	Warning and opportunity to resubmit
Grades 11–12	Warning and opportunity to resubmit	Opportunity to resubmit, maximum grade of 75%

2. Unaccredited Paraphrasing

Unaccredited paraphrasing occurs when a student rewrites another person's ideas without giving proper credit.

Grade Level	First Instance	Subsequent Instances
Grades 9–10	Warning and resubmission allowed	Resubmission allowed, maximum grade of 75%
Grades 11–12	Resubmission allowed, maximum grade of 75%	Resubmission allowed, maximum grade of 50%

3. Unaccredited Verbatim Copying

This occurs when a student copies sentences or passages directly from a source without proper citation.

Grade Level	First Instance	Subsequent Instances
Grades 9–10	Resubmission allowed, maximum grade of 75%	Resubmission allowed, maximum grade of 50%
Grades 11–12	Resubmission allowed, maximum grade of 50%	Grade of zero. No resubmission permitted

4. Full Plagiarism

Full plagiarism occurs when a student submits work entirely created by another person or source.

Grade Level	First Instance	Subsequent Instances
Grades 9–10	Grade of zero. No resubmission	Grade of zero. No resubmission
Grades 11–12	Grade of zero. No resubmission	Grade of zero and possible removal from the course

5. Missed Work

Students are responsible for reviewing lesson materials, completing missed assignments, and meeting established deadlines. Students are expected to remain informed about course expectations, due dates, and assessment requirements.

6. Homework Expectations

Students are expected to:

- Complete homework assignments, readings, and practice problems on time;
- Prepare for scheduled lessons, laboratories, discussions, and assessments;
- Participate actively and consistently in course activities and investigations.

If homework is repeatedly incomplete, the teacher may:

- Schedule a meeting with the student;
- Contact parents or guardians;
- Consult with school administration to support student success and progress.

Inclusion, accommodations & ELL supports

Inukshuk Academy is a small private school with limited accommodation resources. The school is committed to supporting students' access to learning within the scope of available staffing, programming, facilities, and course delivery structures.

Where possible, reasonable accommodations may be provided for students with documented learning needs, including limited support for Individual Education Plans (IEPs). Accommodations are considered on a case-by-case basis in consultation with the student, parents/guardians, teacher, and school administration.

Possible supports may include:

- Clear written instructions and success criteria;
- Guided notes, visual examples, and scaffolded practice;
- Reasonable extended time where appropriate;
- Preferential seating or reduced-distraction work space when available;
- Use of approved assistive technology;
- Check-ins with the teacher to support organization and progress;
- ELL support through simplified instructions, vocabulary support, and additional clarification.

Inukshuk Academy may not be able to provide specialized programming, intensive one-on-one support, modified curriculum expectations, or accommodations requiring resources beyond the school's capacity. Students requiring significant accommodations or specialized services may need additional external support.

Instructional Philosophy

Teaching and learning in SPH4U emphasize:

- Inquiry-based learning through labs and simulations;
- Conceptual understanding supported by real-world applications;
- Mathematical modelling of physical phenomena;
- Multiple representations (equations, graphs, diagrams, physical demonstrations);
- Collaboration through group investigations and discussions;
- Technology integration in data collection, graphing, and analysis.

This approach ensures students engage deeply with physics concepts while developing transferable STEM skills.

Course Learning Resources

Students will engage with a variety of physics learning materials, both digital and print, selected to support inquiry, experimentation, and conceptual development.

a. Primary Resources

- Teacher-created notes, examples, and practice sets
- Physics demonstrations and simulation tools
- Laboratory equipment (sensors, timers, optical equipment)
- *Ontario Curriculum, Grades 11–12: Science (2008)* [1]

b. Digital Tools and Platforms

- PhET Interactive Simulations (fields, waves, quantum effects)
- Pasco/Vernier data acquisition software

- Desmos or GeoGebra for graphing and modelling
- Video analysis tools (e.g., Tracker)

c. Supplementary Resources

- Scientific journals, articles, and multimedia related to physics innovations
- Problem banks and practice exams
- Real-world case studies on physics applications

References

[1] Ministry of Education, "Course Descriptions and Prerequisites," August 2024. [Online]. Available: https://www.dcp.edu.gov.on.ca/en/course-descriptions-and-prerequisites.

[2] Ministry of Education, "Ontario Secondary School Diploma (OSSD) Grade (9-12)," [Online]. Available: https://www.dcp.edu.gov.on.ca/en/.

[3] Ministry of Education, "Growing Sucess," 2010. [Online]. Available: https://www.edu.gov.on.ca/eng/policyfunding/growsuccess.pdf.